AD-A048 972 EPOCH ENGINEERING INC GAITHERSBURG MD F/G 15/5
IDENTIFICATION OF DESIGN PARAMETERS FOR A PRE-STAGED AMMUNITION--ETC(U)
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UNCLASSIFIED 451-1 NL

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DAAK70-77-C-0207

(14) Report No. 451-1

(9) FINAL REPORT.

(6) # IDENTIFICATION OF DESIGN PARAMETERS FOR A PRE-STAGED AMMUNITION LOADING SYSTEM.

(15) DAAK70-77-C-0207

Prepared for

U. S. Army Mobility Equipment Research and Development Command
Fort Belvoir, Virginia 22060

(11) 5 January 5, 1978

(12) 65p.

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S/C 393 693

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I. SUMMARY

The objective of this effort is the establishment and evaluation of operational parameters for an 88" x 216" base area pre-stage ammunition loading system compatible with ANSI/ISO 20-foot containers. Environmental and regulatory restraints pertaining to containers were considered in these efforts. A system design was formulated which is responsive to and compatible with the through-put movement of ammunition from the production facility to the user.

Previous efforts by Control Systems Research, Inc. and Foster-Miller Associates were reviewed as were regulatory documents such as the Code of Federal Regulations, Title 46, Shipping; R. M. Graziano's Tariff No. 31., "Hazardous Materials Regulations of the Department of Transportation"; and the Bureau of Explosives Pamphlets Nos. 6, 6A and 6B, Association of American Railroads.

The DARCOM Ammunition Center at Savanna, Illinois was visited to review ammunition packages, ammunition packaging configurations and ammunition storage facilities. Physical information on all of these items acquired from DARCOM was reviewed and tabulated. Also tabulated were the anticipated load sizes achievable with pre-stage units utilizing both 8-foot high and 8-1/2-foot high containers.

The dimensional characteristics and structural characteristics of the containers were considered as were the means of attaching the pre-stage unit to the container. Possible materials for use in the loading system design were investigated. In addition, material handling equipment presently available at ammunition loading points was considered.

The above information was formulated into a decision (trade-off) matrix. Various methods of achieving each function were listed and compared with each other. This resulted in a listing of operational parameters for pre-stage units. Using the operational parameters as guidelines, a preliminary design for a pre-stage unit was conceived. Performance and cost estimates of the preliminary design were then prepared.

II. PREFACE

This report was prepared by Epoch Engineering, Inc., Gaithersburg, Maryland under USAMERDC Contract No. DAAK 70-77-C-0207 dated 7 Sept 1977. Mr. A. F. Harpine was the Contracting Officer for the Government and Miss Claire Orth and Mr. Rudolph Messerschmidt provided technical direction. Mr. Robert Cecce was responsible for the effort provided by Epoch Engineering, Inc., in this program.

The help and cooperation of the following individuals is gratefully acknowledged:

Mr. Millard Allen, U. S. Coast Guard
Mr. R. M. Graziano, Association of American Railroads
Mr. Donald Willis, DARCOM Ammunition Center
Mr. William Ernst, DARCOM Ammunition Center
Mr. John Bird, DARCOM Annunition Center
Mr. Joseph Sumperer, DARCOM Ammunition Center

The following references were utilized:

1. Code of Federal Regulations 46, Shipping
2. R. M. Graziano's Tariff No. 31, Hazardous Materials Regulations of the Department of Transportation
3. Pamphlet Nos. 6, 6A and 6C, Bureau of Explosives, Association of American Railroads
4. U.S. Army Utilization Procedures for Boxed Ammunition and Milvan Container Loading and Bracing Drawings

III. INTRODUCTION

The objective of this effort is the establishment and evaluation of operational parameters for an 88" x 216" base area pre-stage ammunition loading system compatible with ANSI/ISO 20-foot containers. Environmental and regulatory restraints pertaining to containers are included in these efforts. Their analyses have resulted in a system design that is responsive to and compatible with the through-put movement of ammunition from the production facility to user.

Current procedures for loading ammunition into containers take a considerable amount of time. Present ammunition shipping packages must be stuffed into the container and dunnage put into place. In most cases, when loading of the container is completed, it is not possible to achieve access to inspect the adequacy of the loading and restraint members. At times, such inspections become mandatory, at which time the load must be disassembled and then reassembled under the watchful eye of an inspector. Such a procedure is both time consuming and costly.

There are several facets to be considered when establishing operational parameters for a pre-stage ammunition loading system. These are listed below:

1. Volumetric capacity
2. Structural capability
3. Environmental resistance
4. Materials
5. Cargo restraint on pre-stage unit
6. Pre-stage unit restraint in container
7. Handling requirements, compliancy and limitations
8. Law, regulation and statute requirements and limitations.

Two previous efforts in this area were "Mechanical Dunnage System Kit for Commercial Containers" by Foster-Miller Associates, Inc., and "A Remotely Actuated Floor-Engagement Dunnage System for Containerzied Shipments of Hazardous Materials" by Control Systems Research, Inc.

The scope of work performed in the 90 day technical portion of this contract encompassed the following:

1. Review of reports supplied by the U.S. Army of previous efforts in this area;

2. Review of laws, regulations and statute requirements and limitations relating to shipment of ammunition;

3. Review of the various ammunition package sizes, weights and configurations currently transported by containers;

4. Tabulation of usage factors, equipment availability and locale limitations;

5. Formulation of Design Decision (Trade-Off) Matrix;

6. Establishment of operational parameters;

7. Presentation of a recommended course of action; and

8. Preparation of a preliminary design based on the recommended approach.

IV. INVESTIGATION

Before any appreciable effort could be expended upon the establishment of operational parameters for an ammunition pre-stage unit, it was necessary to first investigate two specific areas. One was the law, regulation and statute requirement and limitations applicable to transportation of ammunition in containers. The second area was that concerning the size, weight, configuration and packaging methods of the basic ammunition pallets and skids currently employed to transport ammunition.

Pursuing the first area, the following documents were investigated:

1. Code of Federal Regulations, Title 46, "Shipping" - These regulations were discussed with Mr. Millard Allen of the U.S. Coast Guard at Mr. Allen's office. Pertinent sections of this code are:
   a. 146.29-42 Containers of ammunition
   b. 146.29-63 Stowage and dunnaging of ammunition and containers of explosives in bulk

   Also discussed were the 80° static tilt test presently employed, the future test requirement of a $\pm 45^{\circ}$ dynamic roll and the 2.5g axial load which the container could have experienced prior to arriving at the dock.

2. R.M. Graziano's Tariff No. 31, "Hazardous Materials Regulations of the Department of Transportation". Pertinent sections of this regulation are:
   a. 174.55 General Requirements
   b. 174.61 Truck bodies, trailer or freight containers on flatcars

c. 174.63 Freight containers and portable tanks
d. 174.101 Loading explosives
e. 174.112 Loading Class B explosives
f. 174.115 Loading class C explosives
g. 176.76 Highway vehicles, railroad vehicles, freight containers and portable tanks containing hazardous materials.

3. Bureau of Explosives Phamplet No. 6, "Illustrating Approved Methods for Loading and Bracing Carload and Less Than Carload Shipments of Explosives and Other Hazardous Materials", Association of American Railroads.

4. Bureau of Explosives Phamphlet No. 6A, "Illustrating Approved Methods for Loading and Bracing Carload Shipments of Military Ammunition and Explosives", Association of American Railroads.

5. Bureau of Explosives Pamphlet No 6C, "Illustrating Approved Methods for Loading and Bracing Trailers and Less-Than-Trailer Shipments of Explosives and Other Hazardous Materials Via Trailer-On-Flat-Car (TOFC) or Container-On-Flat-Car (COFC)", Association of American Railroads.

One repeated instruction of documents 1 and 2 above was the restraint of cargo movement. Documents 3, 4 and 5 illustrate methods utilizing dunnage inside the carrier and are not very relevant to pre-staged loads. Where applicable, documents 1 through 5 were utilized in this effort.

In order to provide parameters for pre-staging cargoes of ammunition, it is imperative to know the sizes, configurations and weights of current individual pallets, skids and containers (or coffins) of the articles to be pre-staged. Also essential was familiarity with current packing arrangements of these items in freight containers.

To obtain this information, a trip was made to DARCOM Ammunition Center in Illinois with the twofold purpose of familiarization with both the basic packages and also the ammunition storage areas such as Igloo, Stradley, etc., magazines. DARCOM personnel described experiences they have had in storing and transporting ammunition, conducted a tour to various types and sizes of magazines and provided drawings of ammunition packages and container configurations, tables of magazine characteristics and a number of background documents.

This information was reviewed and used to prepare the first two columns of Table 4-1, Unit Cargo and Loaded Container Characteristics. The first six columns identify the unit load by military number, give its dimensions and weight and indicate if it is a pallet, a skid or in a few cases a packing container. The military number can be cross-referenced with Table 4-2, Package Listing, which lists the titles of each drawing. The seventh through tenth columns list the loading configurations currently utilized which were also shown on the drawings provided. The final eight columns list proposed loading configurations for a pre-staged unit assuming a unit platform height of no more than 6" above the container floor and the specified dimensions of 216" length and 88" width. Both 8-foot high and 8-1/2-foot high containers are considered.

Table 4-3, DARCOM Magazine Storage, lists the storage capabilities and types at various depots.

Table 4-4, Magazine Characteristics, provides dimensional information for the magazines.

Container door openings considered were:

Container Height, ft	Door Height, inches	Door Width, inches
8	84	90
8-1/2	90	90

TABLE 4-1
UNIT CARGO AND LOADED CONTAINER CHARACTERISTICS

LOAD							CURRENT PACKING 8' CONTAINER				PROPOSED PRE-STAGE UNIT PACKING							
											8' CONTAINER				8½' CONTAINER			
	DWG NO	L	W	H	WT	PALLET OR SKID	TOTAL WT	TOTAL HT	NO/ STACK	STACKS	NO/ STACK	STACKS	TOTAL H	TOTAL WT	NO/ STACK	STACKS	TOTAL H	TOTAL WT
	4116/30	54	42	33.3	1321	P												
	4116/44	52	43.6	38	2200	P												
	4116/44A	49.5	40.5	38.6	2200	P												
	4116/49	50.5	38.4	37	1430	P												
	4116/95	46.8	38	40.8	1920	P												
	4116/106	47	40.5	40	1870	P												
	4116/110	51.5	41	36.3	1080	P												
	4116/122	50.3	45.4	38.8	1490	P												
	4116/128	50.6	42.8	37	1230	P												
	4116/157	48.8	40	40.5	1530	P												
	4138/70	48	25.3	33	294	S												
	4138/70	48	50.5	33	590	S												
D-AMXAC	4261	49.5	40.5	38.5	1670	P	26720	77	2	8	2	8	77	26720				
"	4262	51	44	35.5	2005	P	32080	71	2	8	2	4	71	16040				
"	4263	31.1	33.5	47.3	390	S	5460	47.3	1	14	1	12	47.3	4680				
"	4264	31.1	33.5	33.5	275	S	7700	67	2	14	2	12	67	6600				
"	4265	53.8	42	45.3	2010	P	16080	45.3	1	8	1	6	45.3	12060				
"	4266	53.8	42	38.6	1690	P	27040	75.2	2	8	2	6	75.2	20280				
"	4267	30.5	42	45.8	1040	S	14560	45.8	1	14	1	12	45.8	12480				
"	4268	30.5	42	39.1	865	S	24220	78.2	2	14	1	12	39.1	10380	2	12	78.2	20760
"	4269	48.8	39.8	36	1415	P	25470	72	2	9	2	8	72	22640				
"	4270	36.5	37.3	45	1675	S	20100	45	1	12	1	8	45	13400				
"	4271	44.1	37.1	39.8	1920	S	38400	79.6	2	10	1	8	39.8	15360	2	8	79.6	30720
"	4272	38.6	38.8	46	2000	S	20000	46	1	10	1	8	46	16000				
"	4273	38.6	38.8	38	1610	S	32200	76	2	10	2	8	76	25760				
"	4274	25.5	17	41	935	S	37400	41	1	40	1	40	41	37400				
"	4275	28.5	19.5	38.5	1260	S	37800	38.5	1	30	1	24	38.5	30240				
"	4290	63	43.8	35	2215	P	26580	70	2	6	2	4	70	17720				
"	4291	73	43.8	25.1	1720	P	20460	50.2	2	6	3 ?	4	75.3	20640				
"	4292	61	20.2	25	760	S	29640	75	3	13	3	12	75	27360				
"	4293	71	20.2	25	980	S	35280	75	3	12	3	10	75	29400				
"	4294	52	44	33	2110	P	33760	66	2	8	2	4	66	16880				
"	4295	52	44	42	2780	P	36140	84	2/1	6/1	1	4	42	11120	2	4	84	22240
"	4296	48	41	48.5	2010	P	18090	48.5	1	9	1	8	48.5	16080				
"	4297	48	41	34	1370	P	24660	68	2	9	2	8	68	21920				
	4298	48	40.5	47	1630	P	14670	47	1	9	1	8	47	13040				
"	4299	48	40.5	36.6	1325	P	23850	73.2	2	9	2	8	73.2	21200				
"	4300	48	40	57.3	2045	P	18405	57.3	1	9	1	8	57.3	16360				
"	4301	48	40	40	1400	P	25200	80	2	9	1	8	40	11200	2	8	80	22400
"	4308	46	43.8	50	2250	P	18000	50	1	8	1	4	50	9000				
"	4309	48	40	42	2110	P	35870	84	2/1	8/1	1	8	42	16880	2	8	84	33760
"	4310	48	40	42	2110	P	35870	84	2/1	8/1	1	8	42	16880	2	8	84	33760
"	4313	48	40.5	58.8	2010	P	18090	58.8	1	9	1	8	58.8	16080				
"	4315	48	32	48	1305	P	13050	48	1	10	1	10	48	13050				
"	"	42.4	30	44.8	1045	S	15675	44.8	1	15	1	12	44.8	12540				
"	4316	48	36	38	1700	P	34000	76	2	10	2	8	76	27200				
"	"	49	43	38	2360	P	37760	76	2	8	2	8	76	37760				
"	4317	58.5	45.8	45.6	1700	P	11900	45.6	1	7	1	4	45.6	6800				
"	4319	63.3	38	36.5	1815	S	21780	73	2	6	2	6	73	21780				
"	4320	28.5	19.5	38.5	1216	P	36480	38.5	1	30	1	24	38.5	29180				
"	4324-1	38.5	42.3	46	920	S	9200	46	1	10	1	8	46	7360				
"	" -2	38	40	46	920	S	9200	46	1	10	1	8	46	7360				
"	" -3	43.8	37.5	43.8	1590	S	15900	43.8	1	10	1	8	43.8	12720				
"	4344-1	38.5	42.3	32.5	625	S	12500	65	2	10	2	8	65	10000				
"	" -1A	38.5	42.3	73	1500	S	15000	73	1	10	1	8	73	12000				
"	" -2	38	40	32.5	525	S	12500	65	2	10	2	8	65	10000				
"	" -2A	38	40	73	1500	S	15000	73	1	10	1	8	73	12000				
"	" -3	43.8	37.5	34.3	1200	S	24000	68.6	2	10	2	8	68.8	19200				
"	" -3A	43.8	37.5	62.6	2365	S	23650	62.5	1	10	1	8	62.6	18920				

TABLE 4-1
UNIT CARGO AND LOADED CONTAINER CHARACTERISTICS
(Cont'd)

LOAD							CURRENT PACKING 8' CONTAINER				PROPOSED PRE-STAGE UNIT PACKING							
											8' CONTAINER				8½' CONTAINER			
	DWG NO	L	W	H	WT	PALLET OR SKID	TOTAL WT	TOTAL HT	NO/ STACK	STACKS	NO/ STACK	STACKS	TOTAL H	TOTAL WT	NO/ STACK	STACKS	TOTAL H	TOTAL WT
D-AMXAC	4345	43.8	46	41.5	1810	S	28960	83	2	8	1	4	41.5	7240	2	4	83	14480
"	4346	36.5	37.3	37.3	1485	S	35640	74.6	2	12	2	8	74.6	23760				
"	4349	27	13.5	31.5	800	S	36000	31.5	1	45	1	42	31.5	33600				
"	4353	27	13.5	31.5	800	S	38400	63	1/2	36/6	1	42	31.5	33600				
D-SARAC	4360	63	43.8	35	2215	P	30807	79.9	1	6	2	4	70	17720	1	4	79.9	20580
		63	43.8	44.9	2930	P			1	6	1	4	44.9	11840	1	4		
"	4361	43.8	46	50	2250	S	28960	82.5	1	8	1	4	50	9000	1	4	82.5	14480
		43.8	46	32.5	1370	S			1	8	2	4	65	10960	1	4		
"	4362	52.5	42	43.4	2010	P	29600	80.4	1	8	1	8	43.4	16080	1	8	80.4	29600
		52.5	42	37	1690	P			1	8	2	8	74	27040	1	8		
"	4363	42	30.5	45.8	1040	S	24360	78.3	1	14	1	12	45.8	12480	1	12	78.3	20880
		42	30.5	32.5	700	S			1	14	2	12	65	16800	1	12		
"	4364	55.5	42	49.3	2175	P	26400	77.8	1	8	1	6	77.8	19740				
		55.5	42	28.5	1125	P			1	8	1	6						
		55.5	43.3	49.3	1130	P	26200	77.8	1	8	1	4	77.8	13100				
		55.5	43.3	28.5	2145	P			1	8	1	4						
"	4365	55	40	46	1795	P	23320	77	1	8	1	6	77	17490				
		55	40	31	1120	P			1	8	1	6						
		55	40	46	1780	P	23120	77	1	8	1	6	77	17340				
		55	40	31	1110	P			1	8	1	6						
"	4366	48	40.4	47.4	1430	P	19160	81.4	1	8	1	8	47.4	11440	1	8	81.4	19160
		48	40.4	34	965	P			1	8	1	8			1	8		
		48	40.4	47.4	1455	P	19480	81.4	1	8	1	8	47.4	11640	1	8	81.4	19480
		48	40.4	34	980	P			1	8	2	8	68	15680	1	8		
"	4367	48	42.5	50.3	1545	P	20040	83.3	1	8	1	8	50.3	12360	1	8	83.3	20040
		48	42.5	33	960	P			1	8	2	8	66	15360	1	8		
		48	44	50.3	1550	P	20120	83.3	1	8	1	4	50.3	6200	1	4	83.3	10060
		48	44	33	965	P			1	8	2	4	66	7700	1	4		
"	4368	52.6	42	50.3	1820	P	23640	83.3	1	8	1	8	50.3	14560	1	8	83.3	23640
		52.6	42	33	1135	P			1	8	2	8	66	18160	1	8		
		52.6	44	50.3	1810	P	23640	83.3	1	8	1	4	50.3	7240	1	4	83.3	11760
		52.6	44	33	1130	P			1	8	2	4	66	9040	1	4		
"	4369	58.5	40	47.3	1890	P	20160	74.3	1	7	1	6	74.3	17280				
		58.5	40	27	990	P			1	7	1	6						
		58.5	41	47.3	1900	P	19810	74.3	1	7	1	6	74.3	16980				
		58.5	41	47.3	930	P			1	7	1	6						
D-AMXSV	4251	27	13.5	31.5	800	S	38400	63	1/2	36/6	1	40	31.5	32000				
D-AMXAC	4252	49.1	41.3	51.5	2110	P	16880	51.5	1	8	1	8	51.5	16880				
"	4253	49.1	41.3	40	1600	P	25600	80	2	8	1	8	40	12800	2	8	80	25600
"	4254	48	32.6	43.5	1590	S	15900	43.5	1	10	1	10	43.5	15900				
"	4255	48	32.6	36	1280	S	25600	72	2	10	2	10	72	25600				
"	4256	36	32.6	50.8	1440	S	17280	50.8	1	12	1	12	50.8	17280				
"	4260	49.5	40.5	49.5	2195	P	17560	49.5	1	8	1	8	49.5	17560				
D-SARAC	4370	45.5	35.8	48.5	1570	P	30600	80	1	12	1	8	48.5	12560	1	8	80	20400
		45.5	35.8	31.5	980	P			1	12	2	8	63	15600	1	8		
		45.5	35.8	49.5	1600	P	30360	81.5	1	12	1	8	49.5	12800	1	8	81.5	20240
		45.5	35.8	32	930	P			1	12	2	8	64	14880	1	8		
"	4371	55	40	47	1855	P	22640	74	1	8	1	6	74	16980				
		55	40	27	975	P			1	8	1	6						
		55	43.3	47	1860	P	22720	74	1	8	1	4	74	11360				
		55	43.3	27	980	P			1	8	1	4						
"	4372	55	40	45.5	2000	P	28160	81	1	8	1	6	45.5	12000	1	6	81	21120
		55	40	35.5	1520	P			1	8	1	6	71	18240	1	6		
"	4373	52.5	40.8	49	1695	P	20840	77	1	8	1	8	77	20840				
		52.5	40.8	28	910	P			1	8	1	8						
		53.5	40.8	49	1695	P	20840	77	1	8	1	6	77	15630				
		53.5	40.8	28	910	P			1	8	1	6						

TABLE 4-1
UNIT CARGO AND LOADED CONTAINER CHARACTERISTICS
(Cont'd)

LOAD							CURRENT PACKING 8' CONTAINER				PROPOSED PRE-STAGE UNIT PACKING							
											8' CONTAINER				8½ CONTAINER			
	DWG NO	L	W	H	WT	PALLET OR SKID	TOTAL WT	TOTAL HT	NO/ STACK	STACKS	NO/ STACK	STACKS	TOTAL H	TOTAL WT	NO/ STACK	STACKS	TOTAL H	TOTAL WT
D-SARAC	4374	50	40	49.8	1670	P	21800	82.3	1	8	1	8	49.8	13360	1	8	82.3	21800
		50	40	32.5	1055	P			1	8	2	8	65	16880	1	8		
		52.8	40	49.8	1685	P	21680	82.3	1	8	1	8	49.8	13480	1	8	82.3	21680
		52.8	40	32.5	1025	P			1	8	2	8	65	16400	1	8		
"	4375	49.1	41.3	51.5	2110	P	25840	80	1	8	1	8	51.5	16880	1	8	80	25840
		49.1	41.3	28.5	1120	P			1	8	2	8	57	17920	1	8		
"	4376	48	32.6	43.5	1590	S	28700	79.5	1	10	1	10	43.5	15900	1	10	79.5	28700
		48	32.6	36	1280	S			1	10	2	10	72	25600	1	10		
"	4377	36	32.6	50.8	1440	S	26160	78.8	1	12	1	12	50.8	17280	1	12	78.8	26160
		36	32.6	28	740	S			1	12	2	12	56	17760	1	12		
"	4378	49.5	40.5	49.5	2195	P	26760	77	1	8	1	8	77	26760				
		49.5	40.5	27.5	1150	P			1	8	1	8						
"	4379	51	44	35.5	2005	P	35920	78.5	1	8	2	4	71	16040	1	4	78.5	17960
		51	44	43	2485	P			1	8	1	4	43	9940	1	4		
"	4380	31.1	33.5	47.3	390	S	9310	80.8	1	14	1	12	47.3	4680	1	12	80.0	7980
		31.1	33.5	33.5	275	S			1	14	2	12	67	6600	1	12		
"	4381	36.5	37.3	45	1845	S	39960	82.3	1	12	1	8	45	14760	1	8	82.3	26640
"		36.5	37.3	37.3	1485	S			1	12	1	8	74.6	23760	1	8		
"	4382	38.6	38.9	46.4	2000	S	32200	76.5	1	10	1	8	76.5	25760				
		38.6	38.9	30.1	1220	S			1	10	1	8						
"	4383	48	41	48.5	2010	P	30420	82.5	1	9	1	8	48.5	16080	1	8	82.5	27040
		48	41	34	1370	P			1	9	2	8	68	21920	1	8		
"	4384	48	40.3	47	1630	P	22455	73.3	1	9	1	8	73.3	19960				
		48	40.3	26.3	865	P			1	9	1	8						
"	4385	48	40	74.5	2690	P	24210	74.5	1	9	1	8	74.5	21520				
"	4386	48	32	48	1305	P	22050	82	1	10	1	10	48	13500	1	10	82	22050
		48	32	34	900	P			1	10	2	10	68	18000	1	10		
		42.4	30	44.4	1045	S	28875	82.4	1	15	1	12	44.4	12540	1	12	82.4	23100
		42.4	30	44.4	880	S			1	15	2	12	76	21120	1	12		
"	4387	63.3	38	36.5	1815	S	24390	74.5	1	6	1	6	74.5	24390				
		63.3	38	44.3	2250	S			1	6	1	6						
"	4390	50.5	36.3	45.3	1860	P	29655	79.3	1	9	1	8	45.3	14480	1	8	79.3	26360
		50.5	36.3	34	1435	P			1	9	2	8	68	22960	1	8		
HAWK	5937	216	29.9	79.5	6450	C	19350	79.5	1	3								
"	5946	118.5	20.5	68.6	3385	S	13540	68.6	1	4								
		113.5	20.8	70.1	3275	S	13100	70.1	1	4								
CHAPA-RAL	5944	125	18	19	280	C	4480	76	4	4								
DRAGON	5935	80	47.5	69	1460	P	6424	69	1	4.4	1	4	69	5840				
REDEYE	5929	56.2	40	52.5	685	P	5480	52.5	1	8	1	6	52.5	4110				
"	5941	58.4	40	43.5	660	P	4620	43.5	1	7	1	6	43.5	3960				
DRAGON	5935	47.5	16	16	67	C	7370	80	5	22	4	20	64	5360	5	20	80	6700
REDEYE	5929	56.5	10	15.5	50	C	9000	77.5	5	36	5	24	77.5	6000				
"	5941	56.5	17.5	12.5	74	C	7548	75	6	17	6	14	75	6216				
SHILLE-LAGH	5941	52.5	14.8	14.8	116	C	13920	74	5	24								
TOW	5933	58.3	11.6	11.6	83	C	13944	81.2	6-7	25	6	22	69.6	10956	7	22	81.2	12782
		48	58.3	39.8	1045	P	8360	79.6	2	4	1	4	39.8	4180	2	4	79.6	16720
HONEST JOHN	5949	198.1	41.6	47.4	4800	C	9600	47.4	1	2								
"	5950	146	49.6	56.5	3410	C	6820	56.5	1	2								
NIKE-HER'LES	5953	223.5	54.8	61.5	4606	C	4600	61.5	1	1								
"	5954	107	43.3	47.6	3845	C	15380	47.6	1	4								
"	5955	180.4	46.6	55.7	6520	C	13040	55.7	1	2								

4116/30	FIN,MORTAR CARTRIDGE, M5, FOR 60MM PROJECTILE, TRAINING, M69, PACKED 200 PER WOODEN BOX, UNITIZED 12 BOXES PER 40"X 48" PALLET; APPROX BOX SIZE 273/4 "L X 14" WX 13½" H.
4116/44	90MM CARTRIDGE, PACKED TWO PER WOODEN BOX, UNITIZED 16 BOXES PER "40 X 48" PALLET; APPROX BOX SIZE 43 5/8 "L X 13" W X 8 5/32" H
4116/44A	90MM CARTRIDGE, PACKED TWO PER WIREBOUND BOX, UNITIZED 20 BOXES PER 40" X 48" PALLET; APPROX BOX SIZE 40½ "L X 12 3/8" W X 6 5/8" H
4116/49	BURSTER, PROJECTILE, M71, PACKED 10 PER WOODEN BOX, UNITIZED 20 BOXES PER 35" X 45½" PALLET; APPROX BOX SIZE 25½ "L X 15 "W X7 7/8" H
4116/95	MINE, ANTITANK, HE, LIGHT, M7A2, PACKED TWELVE PER WOODEN BOX, UNITIZED 24 BOXES PER 35" X 45½" PALLET; APPROX BOX SIZE 23 3/8" L X 113/4" W X 9½" H
4116/106	CARTRIDGE, PHOTOFLASH, M112, PACKED 40 PER WOODEN BOX, UNITIZED 24 BOXES PER 35" X 45½" PALLET; APPROX BOX SIZE 20½ "L X 11 3/4 "W X 11½"
4116/110	FLARE, SURFACE-TRIP, M49 SERIES, PACKED 32 PEP WOODEN BOX, UNITIZED 16 BOXES PER 40" X 48" PALLET; APPROX BOX SIZE 20½ "L X 15 3/8" W X 12 7/8" H
4116/122	DESTRUCTOR, EXPLOSIVE-UNIVERSAL, M10, PACKED 50 PER WOODEN BOX, UNITIZED 18 BOXES PER 40" X 48" PALLET; APPROX BOX SIZE 16 3/4" L X 15 1/8 "W X 16 5/8"H
4116/128	FIRING DEVICE, DEMOLITION, MI, PACKED 120 PER WOODEN BOX, UNITIZED 60 BOXES PER 40" X 48" PALLET; APPROX BOX SIZE 14¼ "L X 10 1/8 "W X 7 7/8" H
4116/157	FUZE, PROXIMITY, M517, PACKED 20 PER WOODEN BOX, UNITIZED 30 BOXES PER 40" X 48" PALLET; APPROX BOX SIZE 17½"L X 13 1/8"W X 9 3/4"H
4138/70	66MM ROCKET, M74, INCENDIARY, 4-ROUND CLIP, PACKED FOUR CLIPS PER WIREBOUND BOX, UNITIZED TWO BOXES PER 24" X 47" MODIFIED TYPE II SKID BASE; APPROX BOX SIZE 25½"L X 24"W X 28"H
4261	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 40MM BOXED AMMUNITION (MODIFIED PALLET UNIT) (27-BOX PALLET)
4262	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 57MM HE AMMUNITION (48-BOX PALLET)
4263	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 66MM AMMUNITION (3-BOX UNIT)
4264	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 66MM AMMUNITION (MODIFIED SKIDDED UNIT) (2-BOX UNIT)

TABLE 4-2. PACKAGE LISTING

4265	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 81MM CARTRIDGE, HE 936BOX PALLET)
4266	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 81MM CARTRIDGE, HE (MODIFIED PALLET UNIT) (30-BOX PALLET)
4267	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 81MM CARTRIDGE, ILLUM (18-BOX UNIT)
4268	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 81MM CARTRIDGE, ILLUM (MODIFIED SKIDDED UNIT) (15-BOX UNIT)
4269	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 81MM CARTRIDGE, WP (30-BOX PALLET)
4270	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (15-BOX UNIT)
4271	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (15-BOX UNIT)
4272	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 106MM HE AMMUNITION (15-BOX UNIT)
4273	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 106MM HE AMMUNITION (MODIFIED SKIDDED UNIT) (12-BOX UNIT)
4274	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 175MM SEPARATE LOADING PROJECTILES (6/PALLET)
4275	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 8" SEPARATE LOADING PROJECTILES (6/PALLET)
4290	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 2.75" ROCKET (4 PER 63" LONG BOX PALLET)
4291	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 2.75 ROCKET (4 PER 73" LONG BOX) (10-BOX PALLET)
4292	LOADING AND BRACING IN MILVAN CONTAINERS OF 2.75" ROCKET (25 PER 61" LONG SKIDDED BOX)
4293	LOADING AND BRACING IN MILVAN CONTAINERS OF 2.75" ROCKET (25 PER 71" LONG SKIDDED BOX)
4294	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF FUZES, POINT DETONATING, M557 AND M572 SERIES (36-BOX PALLET)
4295	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF FUZES, POINT DETONATING, M552, M557 AND M572 SERIES (MODIFIED PALLET UNIT) (48-BOX PALLET)
4296	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF MINE, APERS, M18 (36-BOX PALLET)

TABLE 4-2. PACKAGE LISTING (Cont'd)

4297	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF MINE, APERS, M18 (MODIFIED PALLET UNIT) (24-BOX UNIT)
4298	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF GRENADE, FRAGMENT (32-BOX UNIT)
4299	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF GRENADE, FRAGMENT (MODIFIED PALLET UNIT) (24-BOX UNIT)
4300	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF DEMO KIT, CHARGE XM183 (36-BOX PALLET)
4301	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF DEMO KIT, CHARGE XM183 (MODIFIED PALLET UNIT) (24-BOX PALLET)
4308	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (LARGE BOX) (15-BOX UNIT)
4309	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF FUZES, POINT DETONATING, M552, M557, AND M572 SERIES (36-BOX, 42" HIGH PALLET)
4310	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF FUZES, POINT DETONATING, M552, M557 AND M572 SERIES (36-BOX, 42" HIGH PALLET)
4313	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 40MM, M384, BOXED AMMUNITION (36-BOX PALLET)
4315	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED AND SKIDDED UNITS OF 3.5-INCH ROCKET, HEAT, M28 SERIES, PACKED 3 PER BOX (21-BOX PALLET UNIT AND 18-BOX SKIDDED UNIT)
4316	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF SMOKE POT, MI SERIES, GROUND TYPE, WITH HC SMOKE MIXTURE PACKED THREE PER BOX (30-BOX AND 42-BOX PALLET UNITS)
4317	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED MK45 PARACHUTE FLARE PACKED IN PLASTIC CONTAINER (24-CONTAINER PALLET UNIT - OVERPACKED W/3/4" PLYWOOD)
4319	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF DEMOLITION CHARGE, LINEAR, PACKED 2 CHARGES PER WOODEN BOX (16-BOX UNIT)
4320	LOADING AND BRACING IN MILVAN CONTAINERS (METHOD 2) OF PALLETIZED 8-INCH SEPARATE LOADING PROJECTILES (6/PALLET)
4324	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 152 MM CARTRIDGES (INCL CANISTER RDS) PACKED ONE PER WOODEN BOX (9-BOX AND 20-BOX SKIDDED UNITS)
4344	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 152 MM CARTRIDGES (INCL CANISTER RDS) PACKED ONE PER WOODEN BOX (MODIFIED SKIDDED UNITS)

TABLE 4-2. PACKAGE LISTING (Cont'd)

4345	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (LARGE BOX) (MODIFIED SKIDDED UNIT) (12-BOX UNIT)
4346	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (MODIFIED SKIDDED UNIT) (12-BOX UNIT)
4349	LOADING AND BRACING IN MILVAN CONTAINERS (METHOD 2) OF PALLETIZED 155MM SEPARATE LOADING PROJECTILES (8/PALLET)
4353	LOADING AND BRACING IN MILVAN CONTAINERS (METHOD 3, W/O TOMMING) OF PALLETIZED 155 MM SEPARATE LOADING PROJECTILES (8-ROUND PALLET)
4360	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 2.75" ROCKET (4 PER 63" LONG BOX) (MIXED LOAD OF 15-BOX AND 20-BOX PALLET UNITS)
4361	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (LARGE BOX) (MIXED LOAD OF 15-BOX AND 9-BOX SKIDDED UNITS)
4362	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 81MM CARTRIDGE, HE (MIXED LOAD OF 36-BOX AND 30-BOX PALLET UNITS)
4363	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 81MM CARTRIDGE, ILLUM (MIXED LOAD OF 18-BOX AND 12-BOX SKIDDED UNITS)
4364	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M10 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 16-CONTAINER AND 8-CONTAINER PALLET UNITS)
4365	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M13 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 50-CONTAINER AND 30-CONTAINER PALLET UNITS)
4366	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M14 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 42-CONTAINER AND 28-CONTAINER PALLET UNITS)
4367	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M16 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 25-CONTAINER and 25-CONTAINER PALLET UNITS)
4368	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M18 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 50-CONTAINER AND 30-CONTAINER PALLET UNITS)
4369	LOADING AND BRACING IN MILVAN CONTAIMERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M19 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 32-CONTAINER AND 16-CONTAINER PALLET UNITS)

TABLE 4-2. PACKAGE LISTING (Cont'd)

4251	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 155MM SEPARATE LOADING PROJECTILES (8-ROUND PALLET)
4275	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 8" SEPARATE LOADING PROJECTILES (6/PALLET)
4252	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 60MM MORTAR HE AMMUNITION (36-BOX PALLET)
4253	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 60MM MORTAR HE AMMUNITION (MODIFIED PALLET UNIT) (27-BOX PALLET)
4254	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 4.2" CARTRIDGE, HE AND ILLUM (20-BOX UNIT)
4255	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 4.2" CARTRIDGE, HE AND IILUM (MODIFIED SKIDDING UNIT) (16-BOX UNIT)
4256	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 4.2" CARTRIDGE, HE AND ILLUM (18-BOX UNIT)
4260	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED 40MM BOXED AMMUNITION (36-BOX PALLET)
4370	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE PA37AI SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 25-CONTAINER AND 15-CONTAINER PALLET UNITS)
4371	LOADING AND BRACING IN MILVAN CONTAINER OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE M460 SERIES CYLINDRICAL METAL CONTAINER (W/O PROTECTIVE ASSEMBLY) (MIXED LOAD OF 16-CONTAINER AND 8-CONTAINER PALLET UNITS)
4372	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGCE PACKED IN THE M460 SERIES CYLINDRICAL METAL CONTAINER (W/PROTECTIVE ASSEMBLY) (MIXED LOAD OF 16-CONTAINER AND 12-CONTAINER PALLET UNITS)
4373	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE PA66 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 20-CONTAINER AND 10-CONTAINER PALLET UNITS)
4374	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF PROPELLING CHARGE PACKED IN THE PA68 SERIES CYLINDRICAL METAL CONTAINER (MIXED LOAD OF 30-CONTAINER AND 18-CONTAINER PALLET UNITS)
4375	LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 60MM MORTAR, HE AMMUNITION (MIXED LOAD OF 36-BOX AND 18-BOX PALLET UNITS)
4376	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 4.2" CARTRIDGE, HE AND ILLUM (MIXED LOAD OF 20-BOX AND 16-BOX SKIDDED UNITS)
4377	LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 4.2" CARTRIDGE, HE AND ILLUM (MIXED LOAD OF 18-BOX and 9-BOX SKIDDED UNITS)

TABLE 4-2. PACKAGE LISTING (Cont'd)

4378		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 40MM BOXED AMMUNITION (MIXED LOAD OF 36-BOX AND 18-BOX PALLET UNITS)
4379		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 57MM HE AMMUNITION (MIXED LOAD OF 48-BOX AND 60-BOX PALLET UNITS)
4380		LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 66MM AMMUNITION (MIXED LOAD OF 3-BOX AND 2-BOX SKIDDED UNITS)
4381		LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 105MM BOXED AMMUNITION (MIXED LOAD OF 15-BOX AND 12-BOX SKIDDED UNITS)
4382		LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF 106MM HE AMMUNITION (MIXED LOAD OF 15-BOX AND 9-BOX SKIDDED UNITS)
4383		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF MINE, APERS, M18 (MIXED LOAD OF 36-BOX AND 24-BOX PALLET UNITS)
4384		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF GRENADE, FRAGMENTATION (MIXED LOAD OF 32-BOX AND 16-BOX PALLET UNITS)
4385		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF DEMO KIT, CHARGE, MI83 (MODIFIED PALLET UNIT) (48-BOX PALLET)
4386		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED AND SKIDDED UNITS OF 3.5-INCH ROCKET, HEAT, M28 SERIES. PACKED 3 PER BOX (MIXED LOADS OF 21-BOX AND 14-BOX PALLET UNITS AND 18-BOX SKIDDED UNITS)
4387		LOADING AND BRACING IN MILVAN CONTAINERS OF SKIDDED UNITS OF DEMOLITION CHARGE, LINEAR, PACKED 2 CHARGES PER WOODEN BOX (MIXED LOAD OF 16-BOX AND 20-BOX SKIDDED UNITS)
4390		LOADING AND BRACING IN MILVAN CONTAINERS OF PALLETIZED UNITS OF 152MM CARTRIDGE PACKED IN THE PA64 SERIES CYLINDRICAL METAL CONTAINER (MIXED LAOD OF 20-CONTAINER AND 15-CONTAINER PALLET UNITS)
5937	HAWK	LOADING AND BRACING IN MILVAN CONTAINERS OF COMPLETE ROUND, PACKED IN THE M430 OR M611 CONTAINER, FOR SHIPMENT BY T/COFC CARRIER
5946	HAWK	LOADING AND BRACING IN MILVAN CONTAINERS OF ROCKET MOTOR, M22E8 AND M112 SERIES, PACKED IN WOODEN CRANE
5944	CHAPAR-RAL	LOADING AND BRACING IN MILVAN CONTAINERS OF THE COMPLETE ROUND IN THE M570 SHIPPING AND STORAGE CONTAINER
5935	DRAGON	LOADING AND BRACING IN MILVAN CONTAINERS OF GUIDED MISSILE AND LAUNCHER, SURFACE ATTACK, M222 OR PRACTICE, M223, PACKED ONE PER SHIPPING AND STORAGE CONTAINER, UNPALLETED AND PALLETIZED, FOR SHIPMENT BY T/COFC CARRIER

TABLE 4-2. PACKAGE LISTING (Cont'd)

5929	REDEYE	LOADING AND BRACING IN MILVAN CONTAINERS OF COMPLETE ROUND, WITH THREE LAUNCHER BATTERIES, PACKED IN THE UNIPAK CONTAINER, UNPALLETIZED AND PALLETIZED, FOR SHIPMENT BY T/COCF CARRIER
5941	REDEYE	LOADING AND BRACING IN MILVAN CONTAINERS OF COMPLETE ROUND, WITH THREE LAUNCHER BATTERIES PACKED IN THE MONOPAK CONTAINER, UNPALLETIZED AND PALLETIZED, FOR SHIPMENT BY T/COFC CARRIER
5931	SHILLE-LAGH	LOADING AND BRACING IN MILVAN CONTAINERS OF GUIDED MISSILE, PACKED IN THE M555 CONTAINER, UNPALLETIZED AND PALLETIZED, FOR SHIPMENT BY T/COFC CARRIER
5933	TOW	LOADING AND BRACING IN MILVAN CONTAINERS OF GUIDED MISSILE, PACKED ONE PER WIREBOUND WOODEN BOX (OVERPACK), UNPALLETIZED AND PALLETIZED, FOR SHIPMENT BY T/COFC CARRIER
5949	HONEST JOHN	LOADING AND BRACING IN MILVAN CONTAINER OF ROCKET MOTOR, M66, WITH FOUR FINS, PACKED IN WOODEN CONTAINER, FOR THE 762 MM ROCKET, FOR SHIPMENT BY T/COFC CARRIER
5950	HONEST JOHN	LOADING AND BRACING IN MILVAN CONTAINER OF WARHEAD SECTION, PACKED IN WOODEN CONTAINER, FOR THE &62 MM ROCKET, FOR SHIPMENT BY T/COFC CARRIER
5953	NIKE-HERCULES	LOADING AND BRACING IN MILVAN CONTAINERS OF BODY SECTION, PACKED IN THE M410 CONTAINER, FOR SHIPMENT BY T/COFC CARRIER
5954	NIKE-HERCULES	LOADING AND BRACING IN MILVAN CONTAINERS OF THE M30 ROCKET MOTOR IN A WOODEN CONTAINER, FOR SHIPMENT BY T/COFC CARRIER
5955	NIKE-HERCULES	LOADING AND BRACING IN MILVAN CONTAINERS OF THE M42 SERIES ROCKET MOTOR, WITH M24, M65, OR M69 IGNITERS, PACKED ONE PER WOODEN CONTAINER, FOR SHIPMENT BY T/COFC CARRIER

TABLE 4-2. PACKAGE LISTING (Cont'd)

TABLE 4-3. DARCOM MAGAZINE STORAGE

Depot	Igloo 80' Single Door	Igloo 80' Double Door	80' Stradley	Igloo 60' Single Door	Igloo 60' Double Door	Igloo 40' Single Door	Total Earth Covered	Std Above Ground
Anniston	132 S.A.	100 L.A.	478 L.A.	475 S.A. 224 L.A.		6 S.A.	1415	6
Blue Grass	600 S.A.	100 L.A.	0	200 S.A.		2 S.A.	902	12
Letterkenny	596 S.A.	104 L.A.	0	200 S.A.		2 S.A.	902	11
Navajo	141 S.A. 459 L.A.	0	0	185 S.A. 181 L.A.		2 L.A.	801	12
Pueblo	450 S.A. 150 L.A.	120 L.A.	0	50 S.A. 150 L.A.		2 S.A.	922	3
Red River	261 S.A. 116 L.A.	23 L.A.	0	206 S.A. 94 L.A.		2 S.A.	702	18
Savanna	0	0	8 L.A.	383 S.A.	23 L.A.	23 S.A.	437	100
Seneca	100 L.A.	17 L.A.	0	390 L.A.	10 L.A.	2 L.A.	519	8
Sierra	500 S.A. 68 L.A.	32 L.A.	0	100 S.A. 100 L.A.		2 S.A.	802	12
Tooele	140 S.A. 600 L.A.	100 L.A.	0	200 L.A.		2 S.A.	1042	12
Umatilla	104 S.A. 224 L.A.	30 L.A.	0	309 S.A. 332 L.A.		2 S.A.	1001	14
Ft. Wingate	100	80 L.A.	0	550		2 S.A.	732	12
TOTALS	4745	702	486	4162	33	49	10,177	244

S.A. - Small Igloo Apron (7' x 9') Elev 12" to 36" above roadway.
L.A. - Large Igloo Apron (12' x 15') ground level.

TABLE 4-4. MAGAZINE CHARACTERISTICS

Magazine Type	Length, feet	Width, feet	Height, feet	Doors			
				Single		Double	
				Width, inches	Height, inches	Width, inches	Height, inches
Igloo	80, 60 or 40	26.5	12.75	48	90	90	90
Stradley	80, 60 or 40	25.0	14.0			144 120	126 114
Standard Above Ground	215.7	48.7	14.1	94	119		

This data compilation provides all the information necessary to determine the load capabilities, configuration and access limitations of a pre-stage unit. However, before a trade-off analysis and resulting preliminary design can be meaningful to the Army, consideration had to be given to the methods available to the Army to use the pre-stage unit in both the depot and the field.

Overseas operations will often result in a limited variety of equipments available to perform desired functions. It is quite likely that the primary overseas assets available to work with the pre-stage units will not be much more than rough terrain fork lift trucks, 6 x 6 military trucks, flat bed tractor trailer vehicles, crawler or truck chassis cranes and manpower. Considerably more equipment will be available at depots and ammunition plants. Efficient use of these assets should be given a high priority in any trade-off decisions.

Another consideration is the choice of materials used in the pre-stage unit and its associated components. These materials should be well proven by everyday usage. To use unproven materials will result in considerable testing to prove their worth with an ever-present possibility that an entire program would be doomed to failure due to inadequate material capabilities. Minimization of sparking on contact between two materials is very desirable due to the nature of the cargo, namely explosives.

V. ANALYSIS

Utilizing the findings of Section 4 of this report as a basis, the Decision Design (Trade-Off) Matrix shown on Figure 5-1 was formulated.

Item 1. Load sizes and weights - Lists various packaging configurations for a pre-stage unit, including alternative container sizes. The pre-stage unit should be capable of handling as many of the listed loads as possible.

Item 2. Magazine Characteristics - Based on the 88 inch width of the pre-stage unit, only the double door Igloo and Stradley magazines will be compatible with such a system. There are a total of 1221 of these units, comprising 12% of the DARCOM magazine storage capability. In terms of containers, over 13,900 container loads of ammunition could be pre-staged in these magazines if all were so utilized.

Item 3. Cargo Retention - Rigid barriers will add cost and weight. Straps or webbing has proven ineffective to date. Desirable approach are barriers restrained by cables or rods.

Item 4. Stuffing and/or Unstuffing Methods - Accomplishment of these functions by either manpower alone or currently available equipment would be most desirable. Development of special equipment would be costly and time consuming.

Item 5. Unit Loading Methods - Loading cargo on the unit by all normal methods is desirable.

1. Load sizes and weights - package options, container options - See Tables 4-1 and 4-2.
2. Magazine Characteristics - See Tables 4-3 and 4-4.
3. Cargo Retention
    1. Rigid barriers and dunnage
    2. Cable or rod restrained barriers
    3. Straps or webbing
4. Stuffing and/or Unstuffing Methods
    1. Manpower
    2. Currently available equipment
    3. Special equipment
5. Unit Loading Methods
    1. Crane
    2. Fork lift truck
        a. From side
        b. From end
6. Unloading Methods
    1. Crane
    2. Fork lift truck
        a. From side
        b. From end
    3. Skid cargo and fork lift truck
    4. Dump cargo
    5. Dump loaded unit
7. Loading Options
    1. Preloaded unit stored in bunker
    2. Fast load at Igloo with unit on flat bed truck-transport to container and stuff

Figure 5-1. Design Decision (Trade-Off) Matrix

8. Unit Lifting Methods
    1. Fork lift truck
    2. Crane
    3. Elevating platform
    4. Jacks
    5. Special equipment
9. Storage Options
    1. Pre-loaded units in double door Igloos or Stradleys
    2. Loaded units in containers in above ground buildings
    3. Loaded units in containers in open top depressions
    4. Loaded containers in Igloos with enlarged doors
10. Transporting Method
    1. Flat bed truck
    2. Container
    3. Open railroad car
    4. Railroad boxcar
11. Unit Configuration
    1. Single 216" x 88" platform
    2. Two 108" x 88" platforms
        a. Coupled platforms
        b. Separate platforms
        c. Rigid platform
        d. Flexible platform
12. Restraint in Container
    1. Tracks and stops
    2. Floor attachments
13. Unit Support
    1. Wheels
    2. Rollers
    3. Air bearing
    4. Tracks
    5. Forklift truck(s)

Figure 5-1. Design Decision (Trade-Off) Matrix (Cont'd)

14. Stuffing Guides
    1. Side rails
    2. Center rail
    3. None
    4. Cables
    5. Air bearings

15. Unit Handling in Bunker
    1. Forklift truck
    2. Manpower brute force
    3. Internal guide rails, end shuttle and door rails
        a. Engine or motor powered
        b. Manpowered
    4. Special equipment

16. Stacking Methods
    1. Lugs and sockets with straps or webbing
    2. Through holes with vertical attachments

Figure 5-1. Design Decision (Trade-Off) Matrix (Cont'd)

Item 6. Unloading Methods - Capability to unload cargo by all the listed methods is desirable.

Item 7. Loading Options - Accomplishment of both options is desirable.

Item 8. Unit Lifting Methods - Elevating equipment, jacks and special equipment are costly and/or time consuming. Lifting by forklift truck and cranes is more desirable. However, due to the desirability of a low profile platform, direct lifting by forks may not be possible. A forklift truck overhead gooseneck adapter with spreaders and lifting cables can circumvent this problem.

Item 9. Storage Options - Options 2 and 3 are not acceptable from the standpoint of safety. Pre-loaded units in double-door Igloos or Stradleys is compatible with the pre-stage concept. Alternatively, loaded containers which were inspected during loading could be stored in Stradleys or in Igloos with enlarged doors. This would eliminate the need for pre-staged units and those funds applied to enlarging magazine doors. On the negative side, dunnage in containers stored for a lengthy period of time could deteriorate rendering the container unsafe. This would revert to the situation presently existent.

Item 10. Transporting Method - Accomplishment of all the methods listed in the matrix would be desirable.

Item 11. Unit Configuration - The major decision to be made here is the length of the pre-stage unit. For the same unit distributed load per unit length, the 216" platform will experience four times the bending load of the 108" unit. Assuming that the platform height will be the same in both cases, the 216" platform will approach twice the weight of <u>two</u> 108" platforms. The 108" platform offers the additional advantage of being sufficiently small for transport by a 6 x 6 military truck, a situtation not possible with the 216" platform.

Item 11. (Cont'd) Despite these advantages for the 108" platform, several missile cargoes require the long platform due to the missile length. A mitigating feature of the long missile is its lighter weight. If a long platform were utilized for missiles only, it can be constructed lighter than a general purpose platform.

Item 12. Restraint in Container - Attaching the cargo directly to the container floor is one of the limitations of the present method. Tracks attached to the container floor permit verification of the adequacy of the installation, It is desirable that the track attachments not be subjected to bending loads. Stops attached to the tracks can be used to restrain the pre-stage units in the container. In addition to providing restraint, the tracks can also act as guides when stuffing or unstuffing the pre-stage units.

Item 13. Unit Support - With the weights involved in this system, air bearings and rough terrain forklift trucks do not appear practical for movement of the pre-stage units. Air bearings would probably have clearances on the order of .050 inch or less, thus being susceptible to interference with debris or high spots on the container floor. Since it is likely that even a short platform can weigh 20,000 pounds, the rough terrain forklift truck load capacity is insufficient to remove a loaded platform or transfer it to a 6 x 6 truck. The simplest and most reliable method of support for a unit of this weight are wheels or rollers riding on metal tracks. High capacity commercial roller assemblies are readily available and are well proven in rough usage. They are low in profile and distribute the load over several rollers. In operation, the rollers act as rollers in a roller bearing, the cross plate of the roller assembly acting as the inner race and the floor or track under the rollers acting as the outer bearing race. As a result, the individual rollers are considerably larger than those that could be

Item 13. (Cont'd) fitted in wheels requiring a higher profile. In any case, either wheels or rollers should be operated on metal tracks or plates.

Item 14. Stuffing Guides - In many cases, as the loaded pre-stage unit is inserted in the container, the only portion of the unit accessible for control or guidance is the end facing the container door. In the interests of simplicity, positive guidance and reliability, guide rails should be utilized. If the guide rail or rails react loads incurred in container transport, side rails are preferable since they are closer to the main container longitudinal structural members. This closer proximity to the main container longitudinal member minimizes the distance that any loads have to travel through the container structure and floor, thus minimizing bending moments, etc. on the container members.

Item 15. Unit Handling in Magazine - Some potential obstacles to using a forklift truck to move loaded pre-stage units inside the magazine are listed below;

1. The door opening may not permit entry of a sufficiently large truck;
2. Restricted interior space will likely prevent efficient storage of pre-stage units;
3. There may be a step between the magazine floor and the apron.

The weight of a loaded pre-stage unit would render the use of manpower brute force time consuming or impossible. If the pre-stage units have self-contained wheels or rollers, they can be stored on three parallel sets of guide rails running the length of the bunker. This arrangement would allow the rows of pre-stage units to be as close as two inches apart without operational interference. A cross shuttle at the door end of the magazine would position each unit in line with its storage row. Such a system could be manpowered or mechanically powered, using conventional proven components.

Item 16. Stacking Methods - Any stacking method will be dependent upon the configuration of the pre-stage unit developed. It is possible that stacking may not be feasible. Of the two presented herein, the lugs and sockets with straps or webbing appears the more desirable from the standpoint of attachment access.

Based upon this analysis, operational parameters were established as shown on Table 5-1.

TABLE 5-1. LIST OF OPERATIONAL PARAMETERS

1. When installed in a container, the configuration of loaded pre-stage units must not exceed 216" in length, 88" in width and either 82" in height for 8-foot containers or 88" in height for 8½ foot containers exclusive of guides or guide rail lengths. Guides may extend the full length of the container but must be usable on all containers.

2. The unit must be able to support and restrain 38,000 pounds of cargo in addition to its own weight of approximately 2000 pounds, when subjected to a 1.0g side load, 2.5g end load and a 2.0g (including cargo weight) vertical load. It must also support and restrain the cargo when the container is transported by truck, rail or ship. The pre-staged unit must be so secured in the container that it cannot move more than 0.06 inches vertically or sideways and cannot move at all axially. The cargo should not permanently shift more than .75 inches sideways or 1.5 inches axially at any point. If the cargo can shift and then spring back, the maximum excursion shall not exceed 1.5 inches sideways or 3.0 inches axially.

3. The pre-stage unit must be so designed that it can be stuffed or unstuffed by manpower alone. Additionally, stuffing or unstuffing by powered devices is permissible and desirable.

TABLE 5-1. LIST OF OPERATIONAL PARAMETERS (Cont'd)

4. Cargo elements to be transported on the pre-stage unit are listed in Table 4-1. The configuration of these elements are shown on the drawings referenced in Table 4-1. The pre-stage unit should accept these elements in such a manner as to maximize container loads consistant with pre-stage unit restrictions and container capacity.

5. The pre-stage unit must be capable of transport in a fully loaded condition on a flat bed truck or a trailer. It must also be capable of transfer from the truck bed into a container or from a container to the truck bed.

6. All operating components of the pre-stage unit system must be readily accessible at any time when the normal operation accessibility of that component is required.

7. The pre-stage unit must be capable of being lifted by its corners in a fully loaded condition.

8. The pre-stage unit system should be capable of installation in as many different make and model containers as practical to include steel, aluminum, and FRP/Plywood types.

9. The pre-stage unit system should be capable of being removable and reusable.

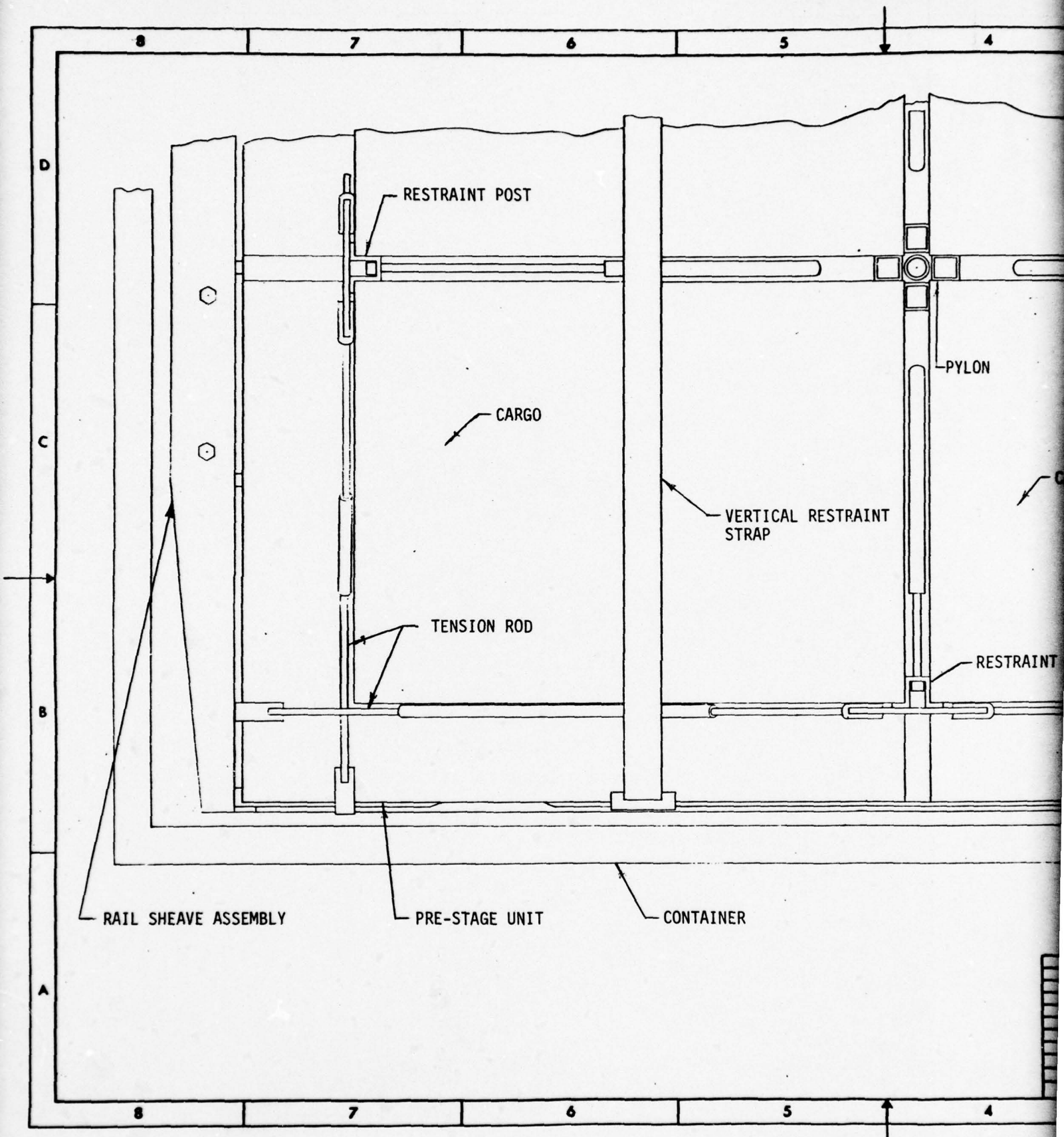
10. No more than 8 man hours of labor should be required to install the pre-stage unit system using conventional hand-held portable powered tools with the container floor resting raised approximately 60 inches above ground level. Temporary jigs and fixtures may be used to facilitate rapid installation.

VI. PRELIMINARY DESIGN

A preliminary design of a pre-stage unit conforming to the operational parameters of Section V is presented on Figures 6-1 through 6-10. As can be seen, the pre-stage unit consists of a welded platform with a structure of five cross channels, three longitudinal tubes, two longitudinal channels and two longitudinal I-beams. At two points on either side are horizontal plates to which are attached roller assemblies (Hillman Equipment Co., or equivalent). At each end on either side of the central tube are extraction lugs to pull the unit out of the container. The upper surface of the platform is a metal sheet with grooves for the bases of restraint posts, socket holes for the base of a pylon and socket holes for twist lock attachments that hold the pylon in place.

The pylon consists of four legs spaced 90° apart about a central vertical tube. The base of the central tube fits into one of the pylon socket holes on the platform upper surface. A twist lock is located at the outer end of each leg of the pylon. In order to mount the pylon, all four twist locks must be parallel to the centerline of the platform. As the central tube is inserted into a pylon socket, the locking lugs of the twist locks will be inserted into four twist lock sockets on the platform. Turning each twist lock 90° will firmly attach the pylon to the platform.

Extending from each leg of the pylon are two long restraint nuts pivoted to the pylon at their inner ends. Restraint bolts, passing through hat shaped restraint posts, attach to the restraint nuts. The lower end of each restraint posts fits into a socket groove on the upper surface of the platform. Two adjustable tension rods are attached to lugs at the upper end of each restraint post. Hooks on the lower ends of the tension rods grab the upper flange of the platform. Horizontal restraint straps hook into the groove of the restraint posts and vertical restraint straps onto the upper flange of the platform.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RESTRAINT POST
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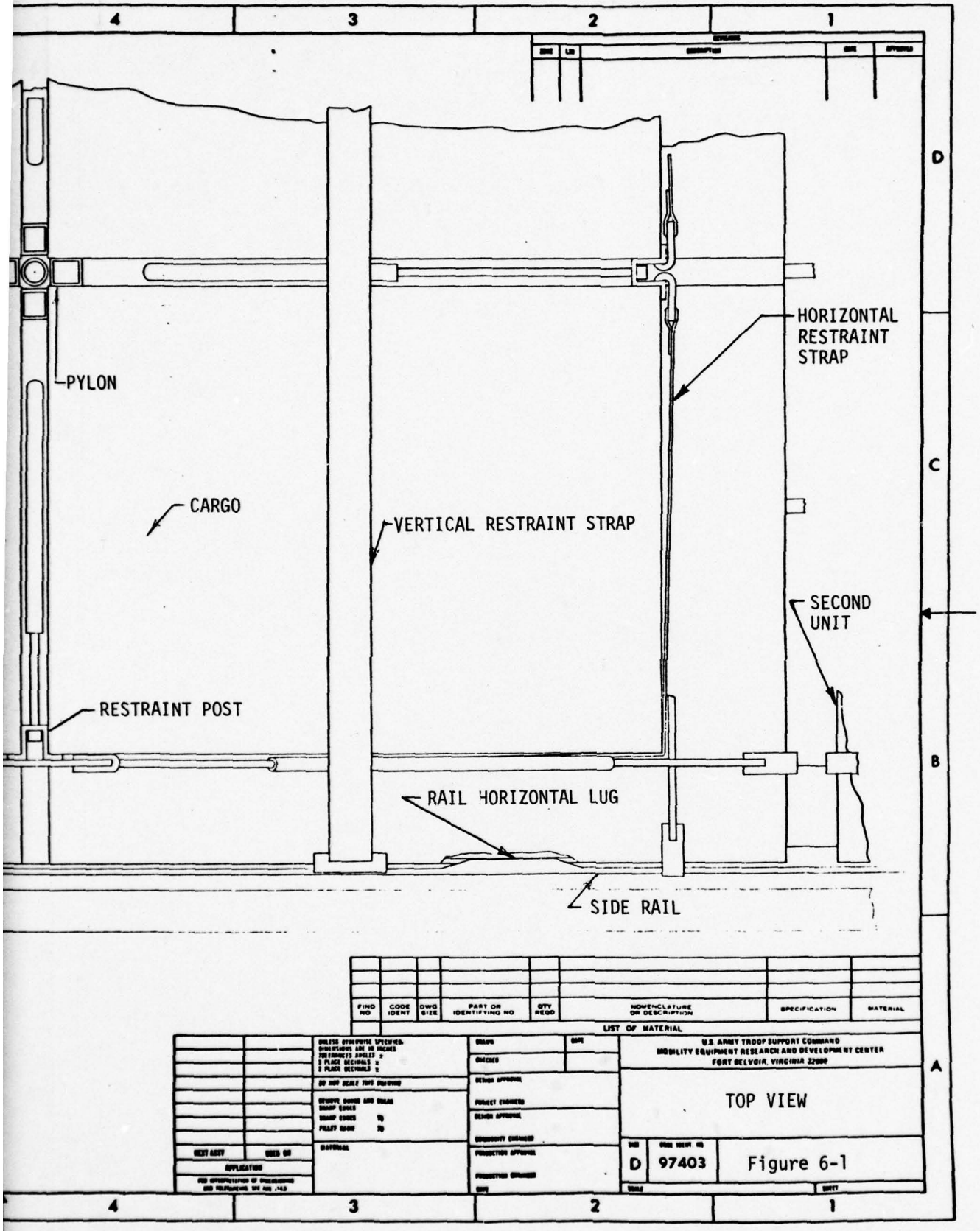
CARGO
VERTICAL RESTRAINT STRAP
TENSION ROD
RESTRAINT
RAIL SHEAVE ASSEMBLY
PRE-STAGE UNIT
CONTAINER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PYLON
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RESTRAINT POST
RAIL HORIZONTAL LUG
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U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060
TOP VIEW
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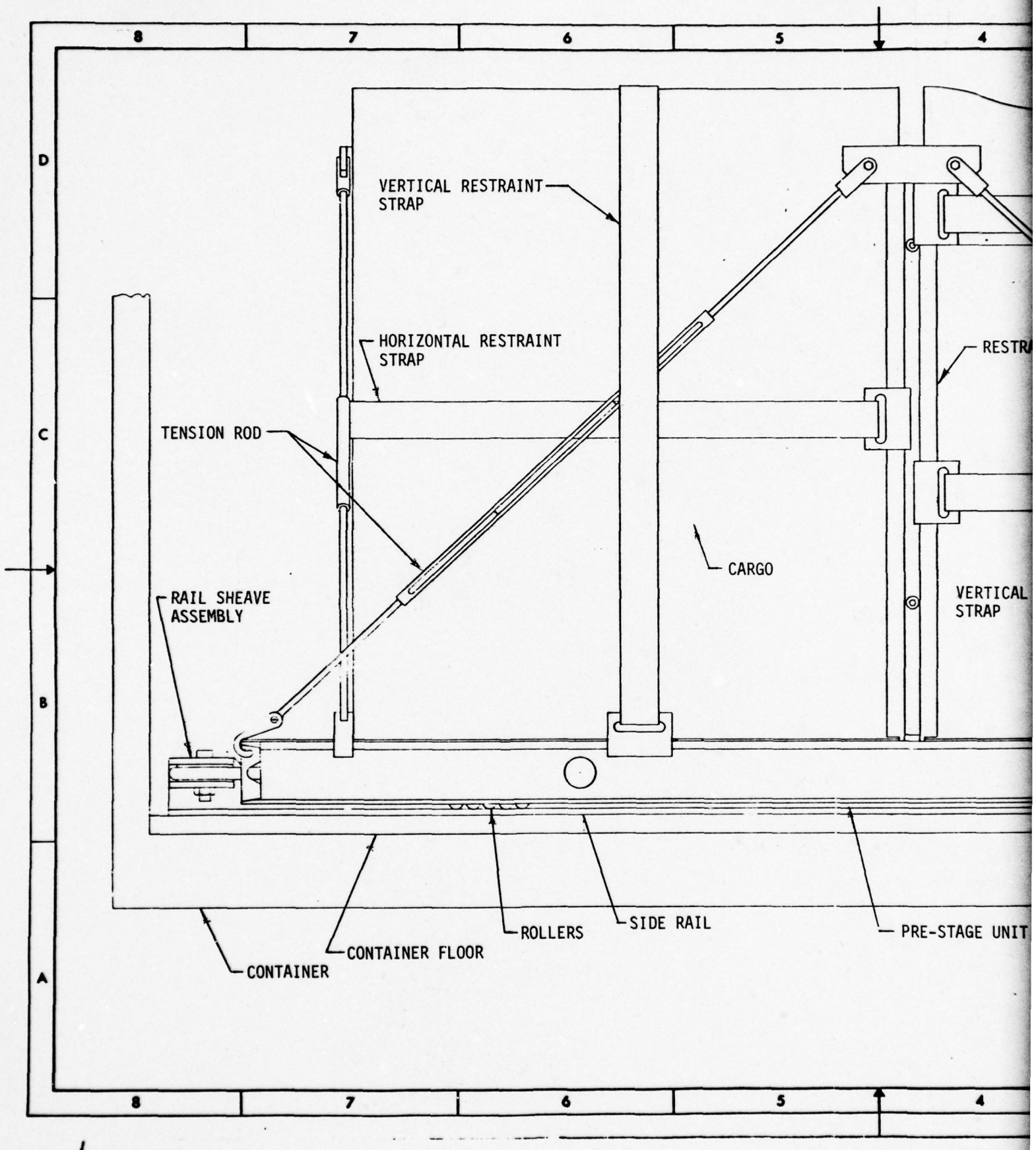
Figure 6-1

2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HORIZONTAL RESTRAINT STRAP
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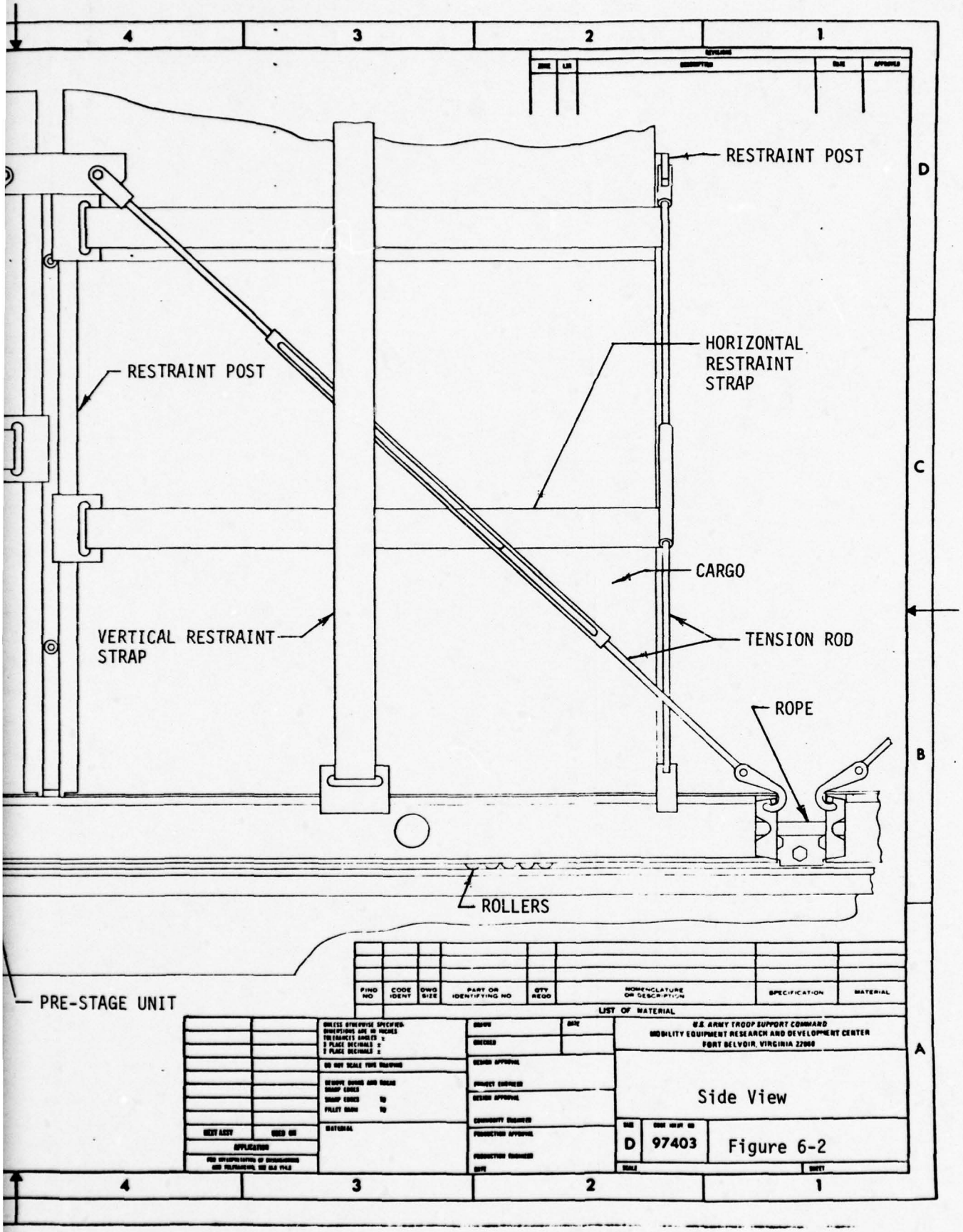
RAIL SHEAVE ASSEMBLY
VERTICAL STRAP
ROLLERS
SIDE RAIL
PRE-STAGE UNIT
CONTAINER
CONTAINER FLOOR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HORIZONTAL RESTRAINT STRAP
RESTRAINT POST
CARGO
VERTICAL RESTRAINT STRAP
TENSION ROD
ROPE
ROLLERS
PRE-STAGE UNIT
LIST OF MATERIAL
U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060
Side View
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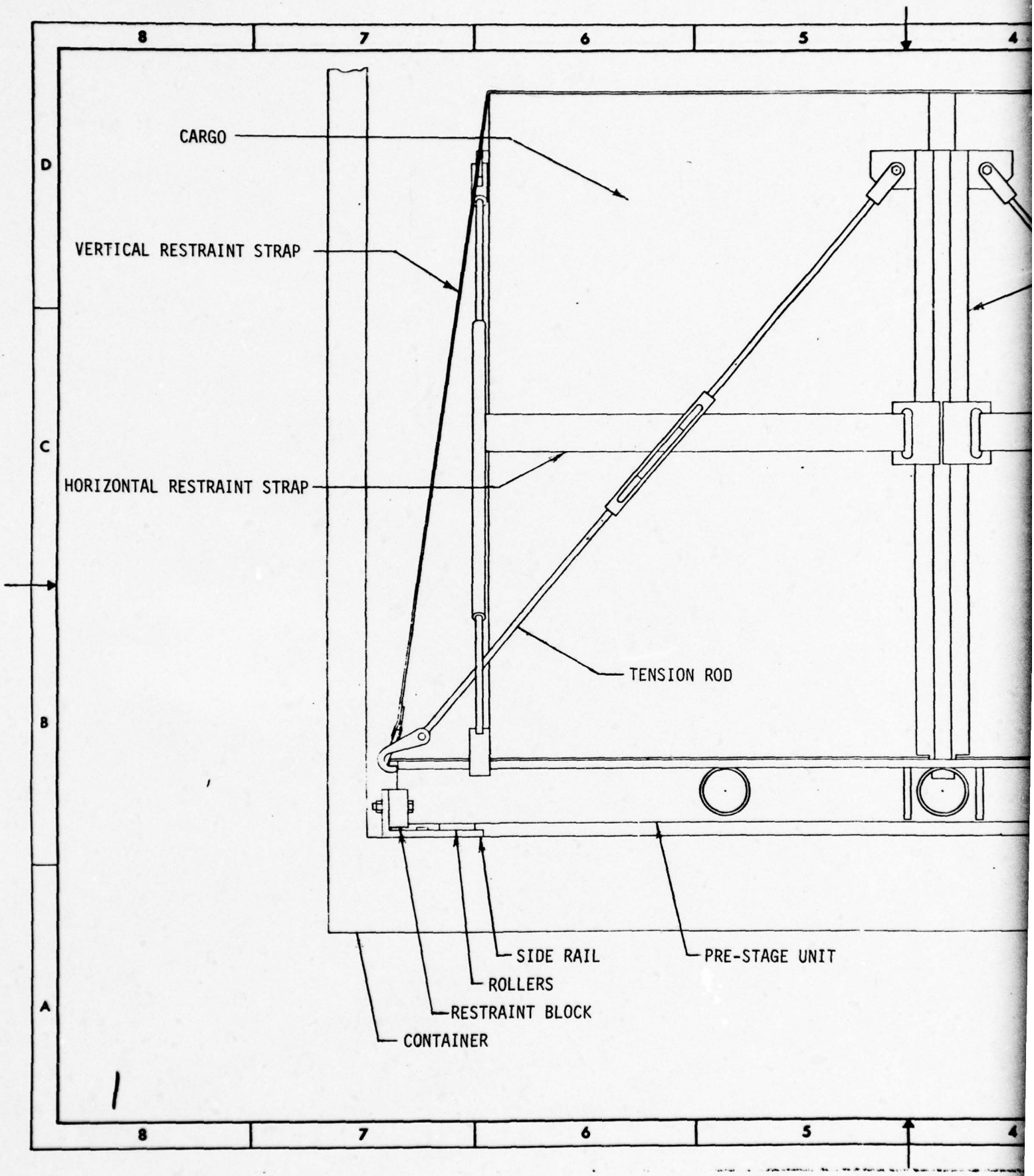
Figure 6-2

2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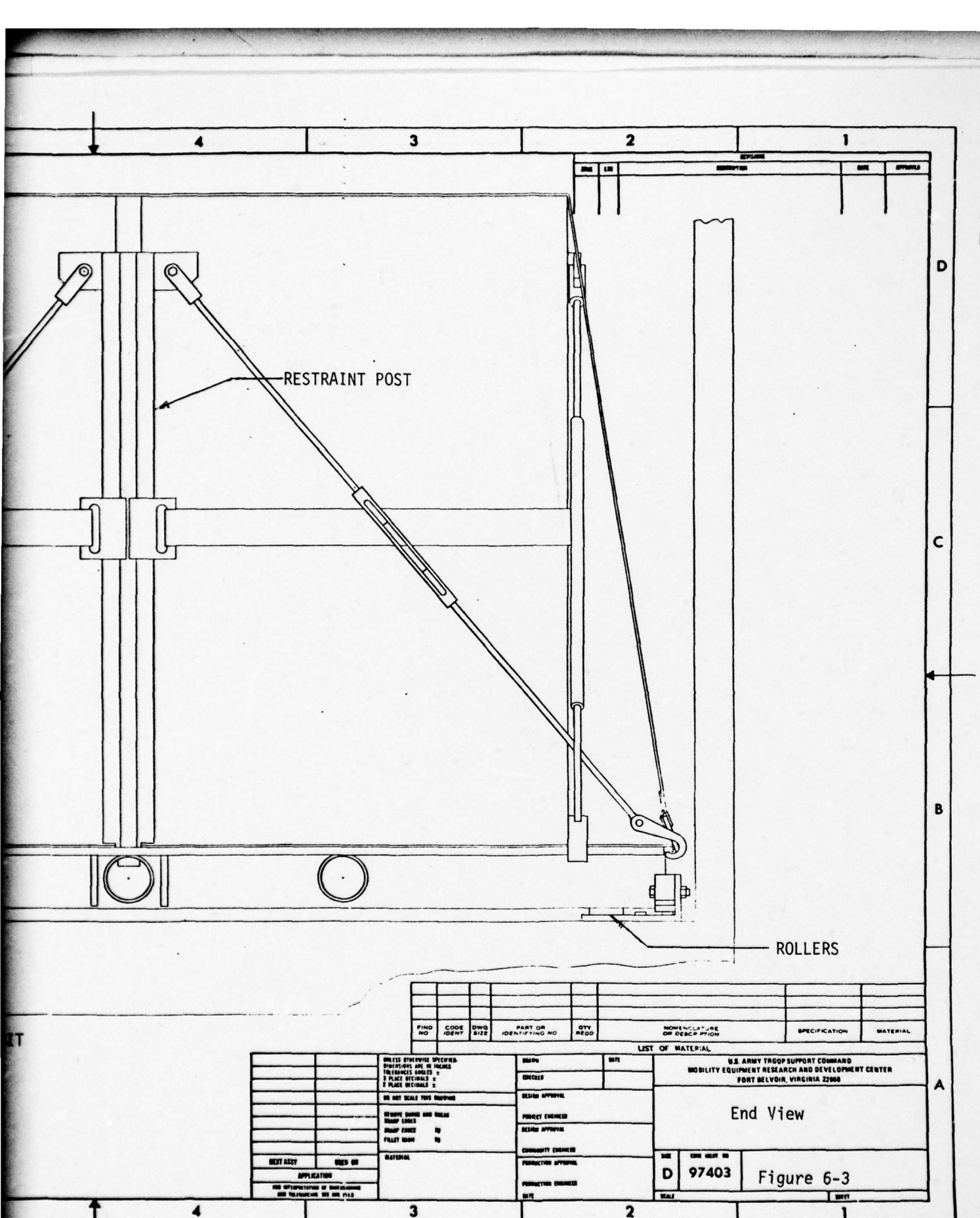
SIDE RAIL
ROLLERS
RESTRAINT BLOCK
CONTAINER
PRE-STAGE UNIT



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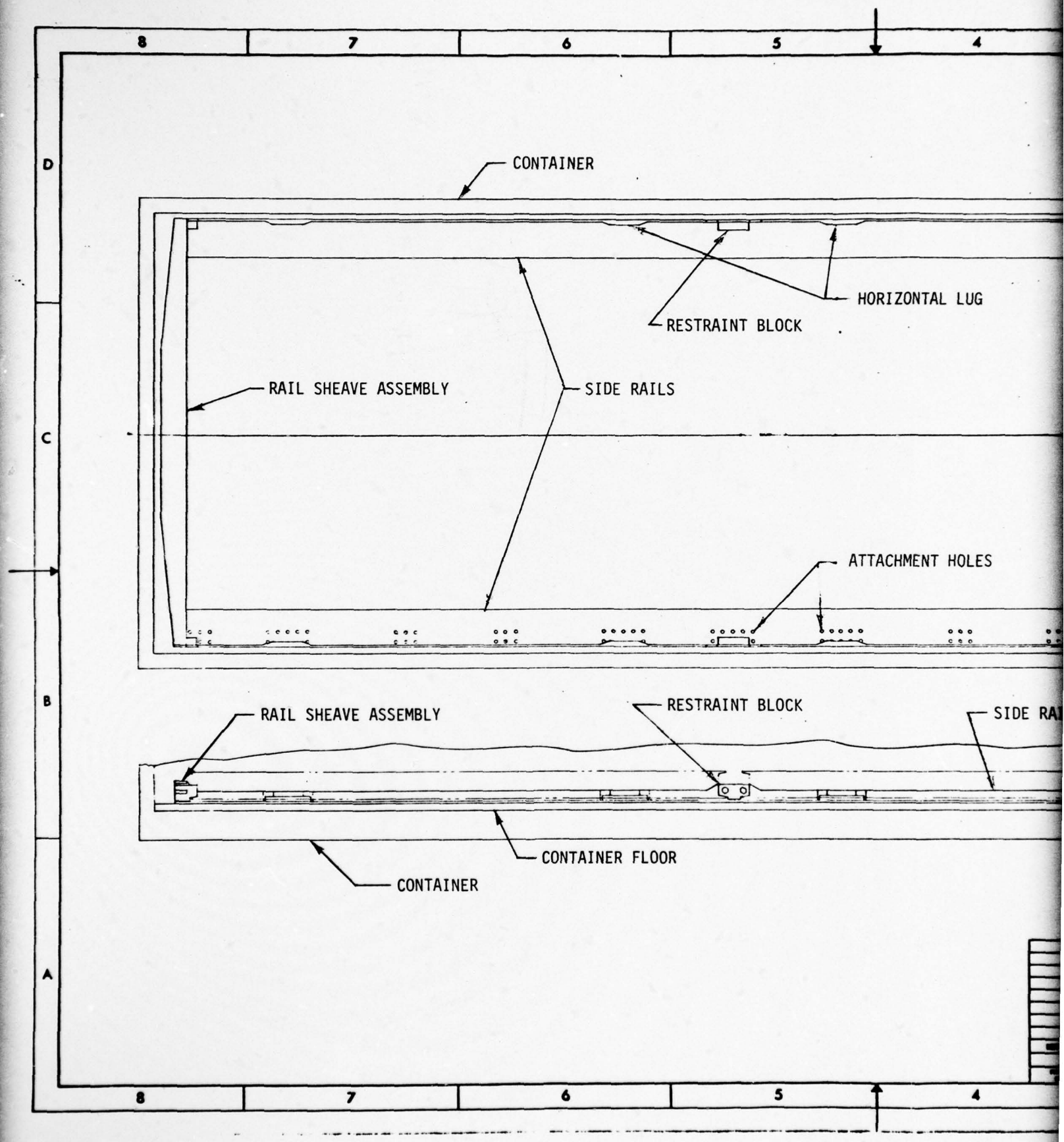
LIST OF MATERIAL

U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

End View

D 97403

Figure 6-3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RESTRAINT BLOCK
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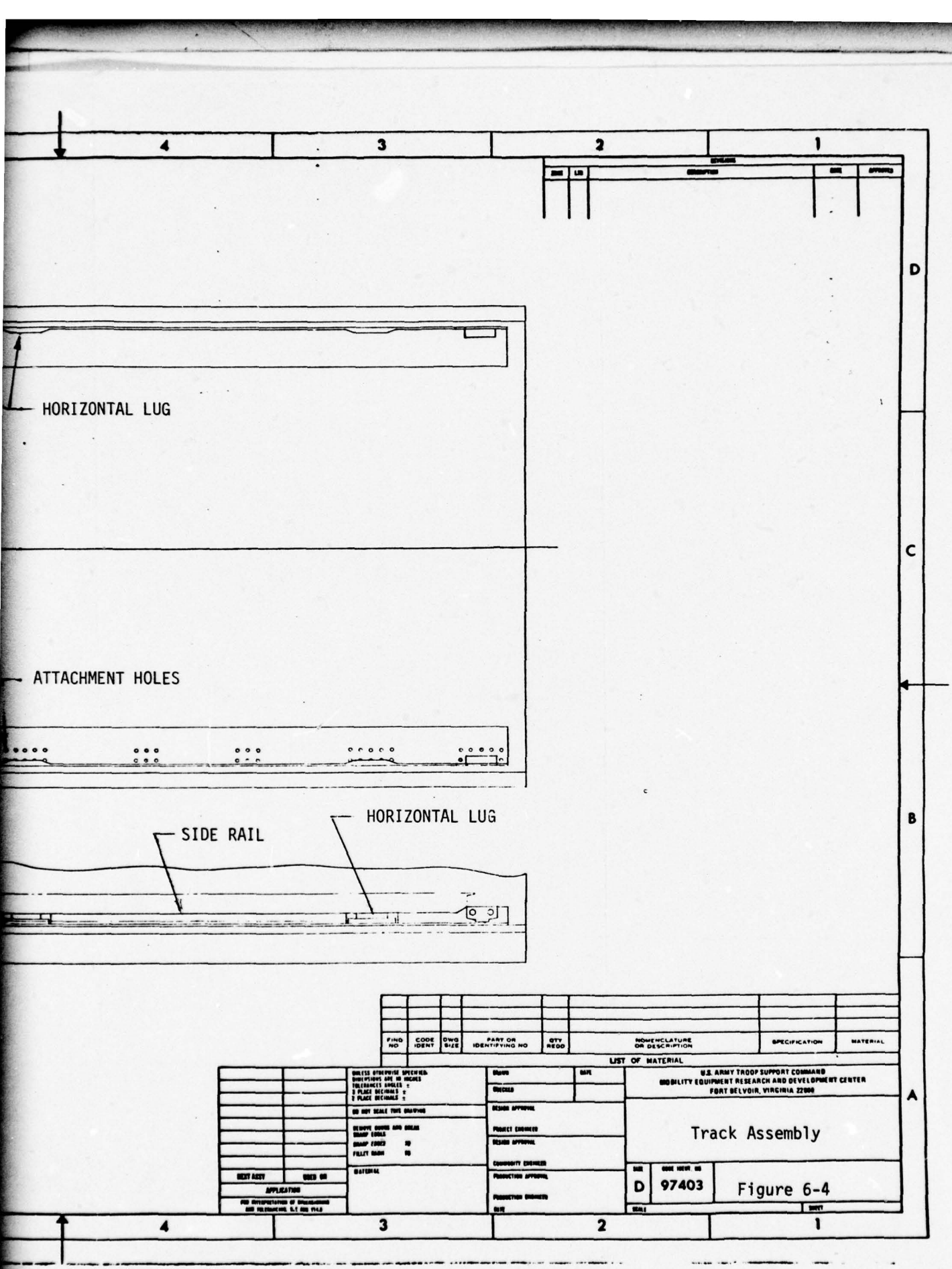
ATTACHMENT HOLES
RAIL SHEAVE ASSEMBLY
RESTRAINT BLOCK
SIDE RAI
CONTAINER FLOOR
CONTAINER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ATTACHMENT HOLES
SIDE RAIL
HORIZONTAL LUG
LIST OF MATERIAL
U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060
Track Assembly
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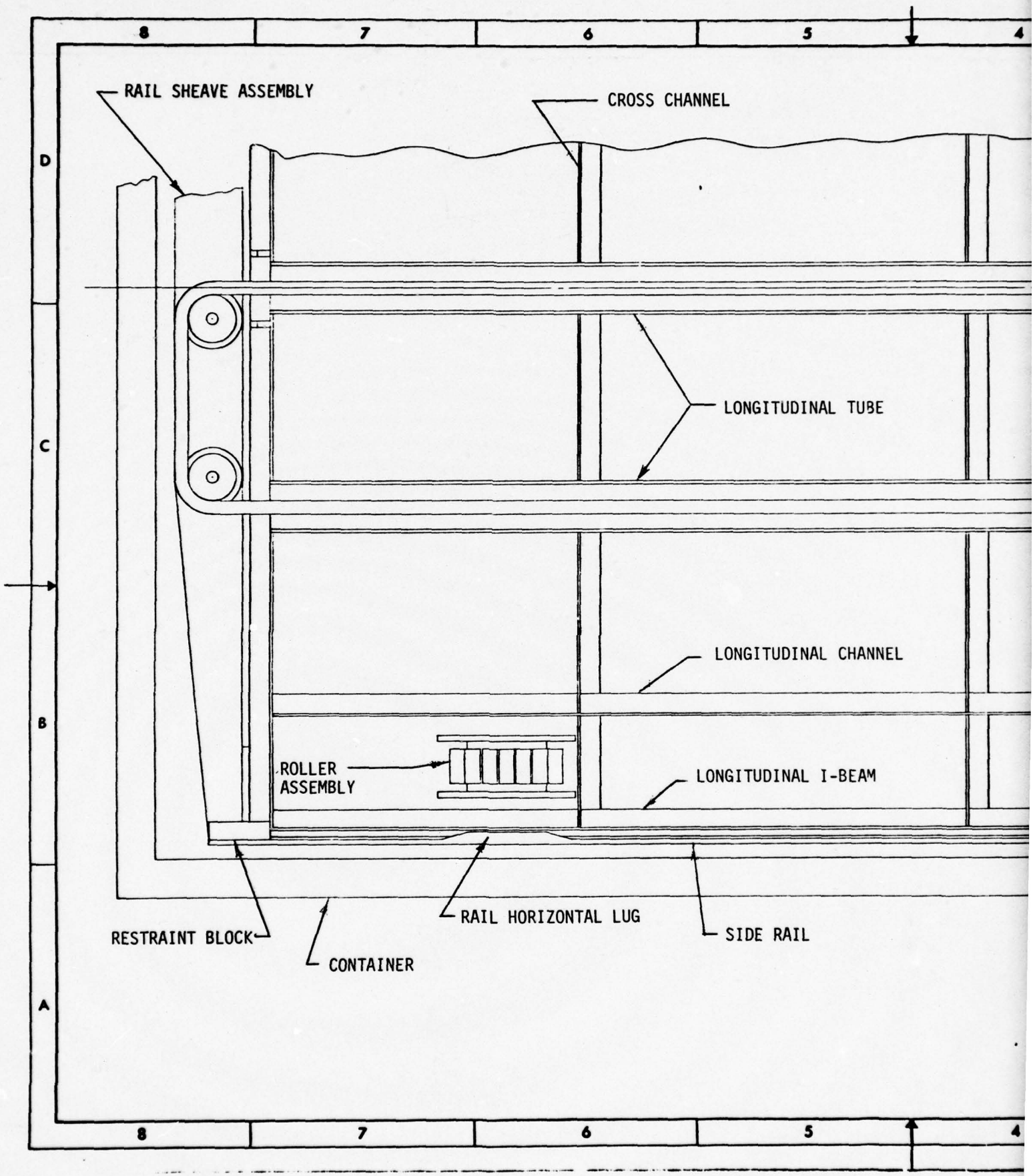
97403
Figure 6-4

2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LONGITUDINAL CHANNEL
ROLLER ASSEMBLY
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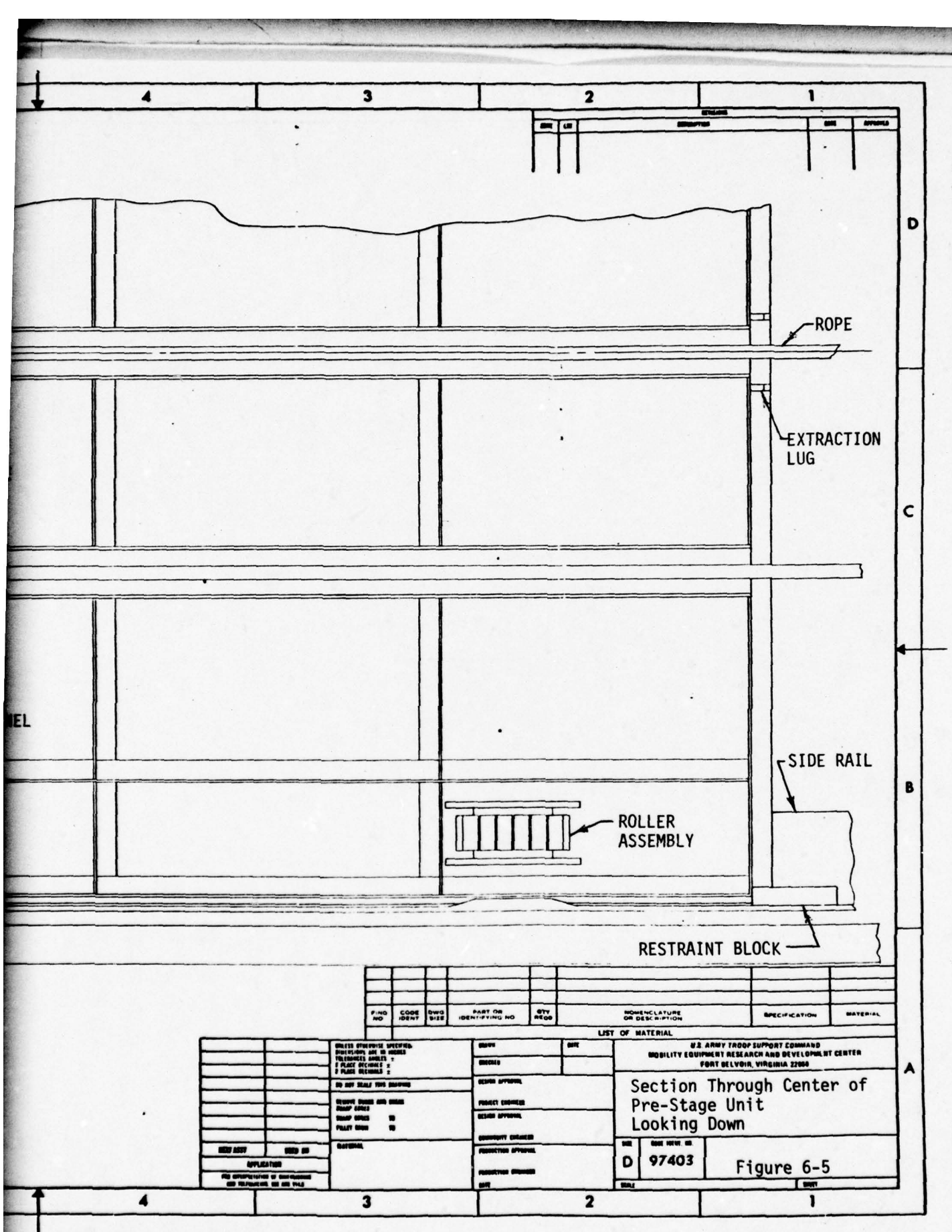
SIDE RAIL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U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060
Section Through Center of Pre-Stage Unit Looking Down
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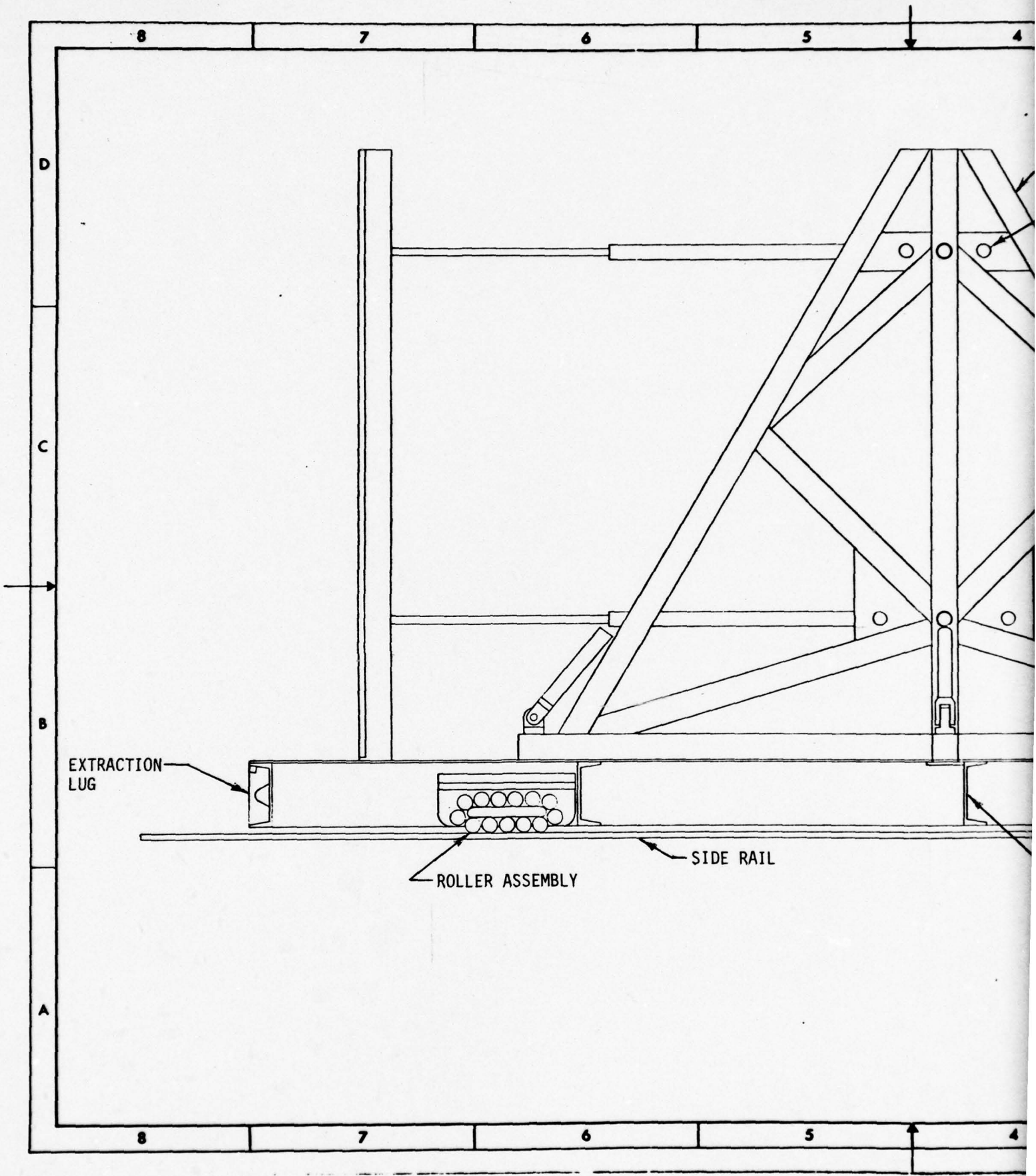
Figure 6-5



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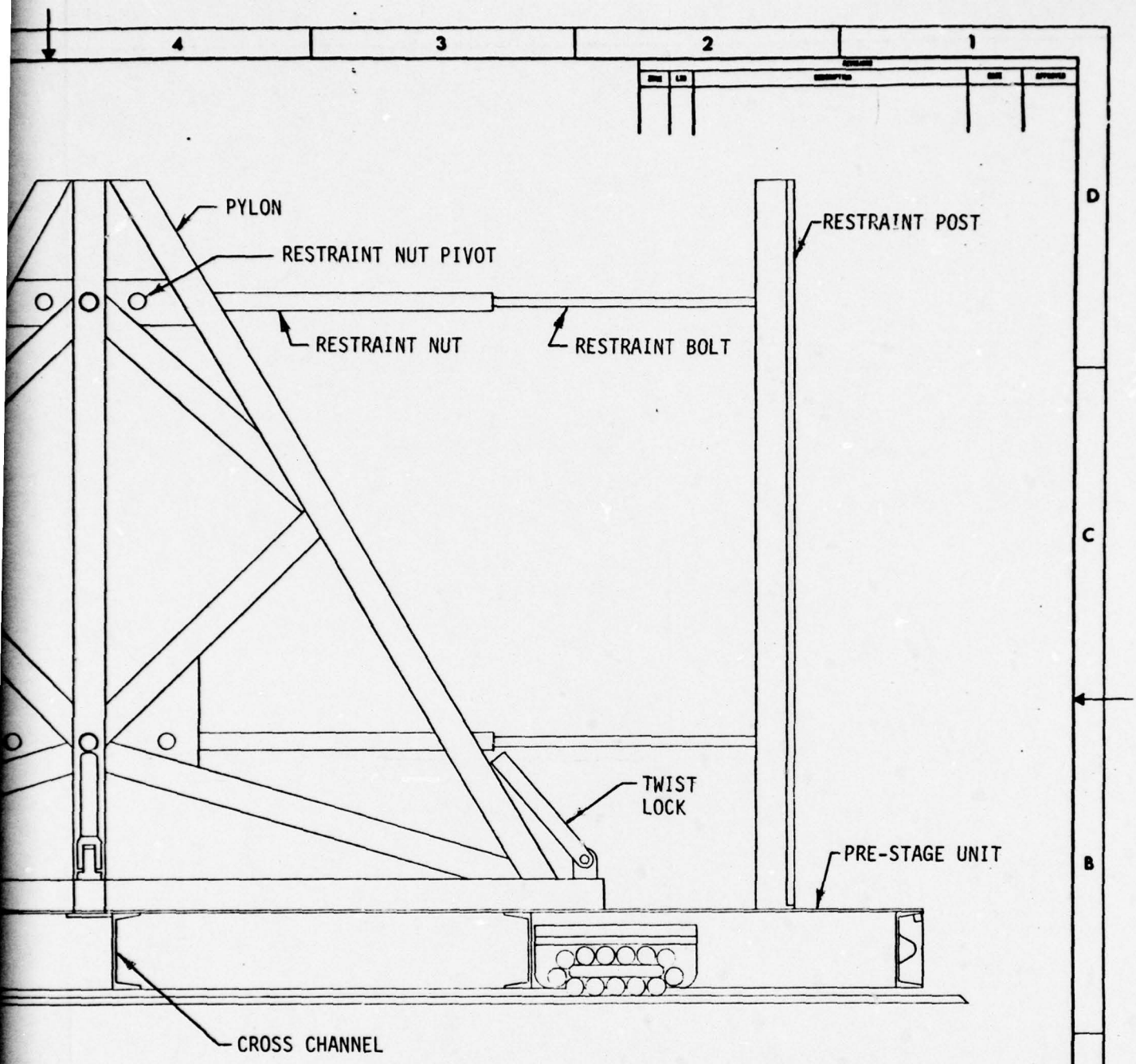

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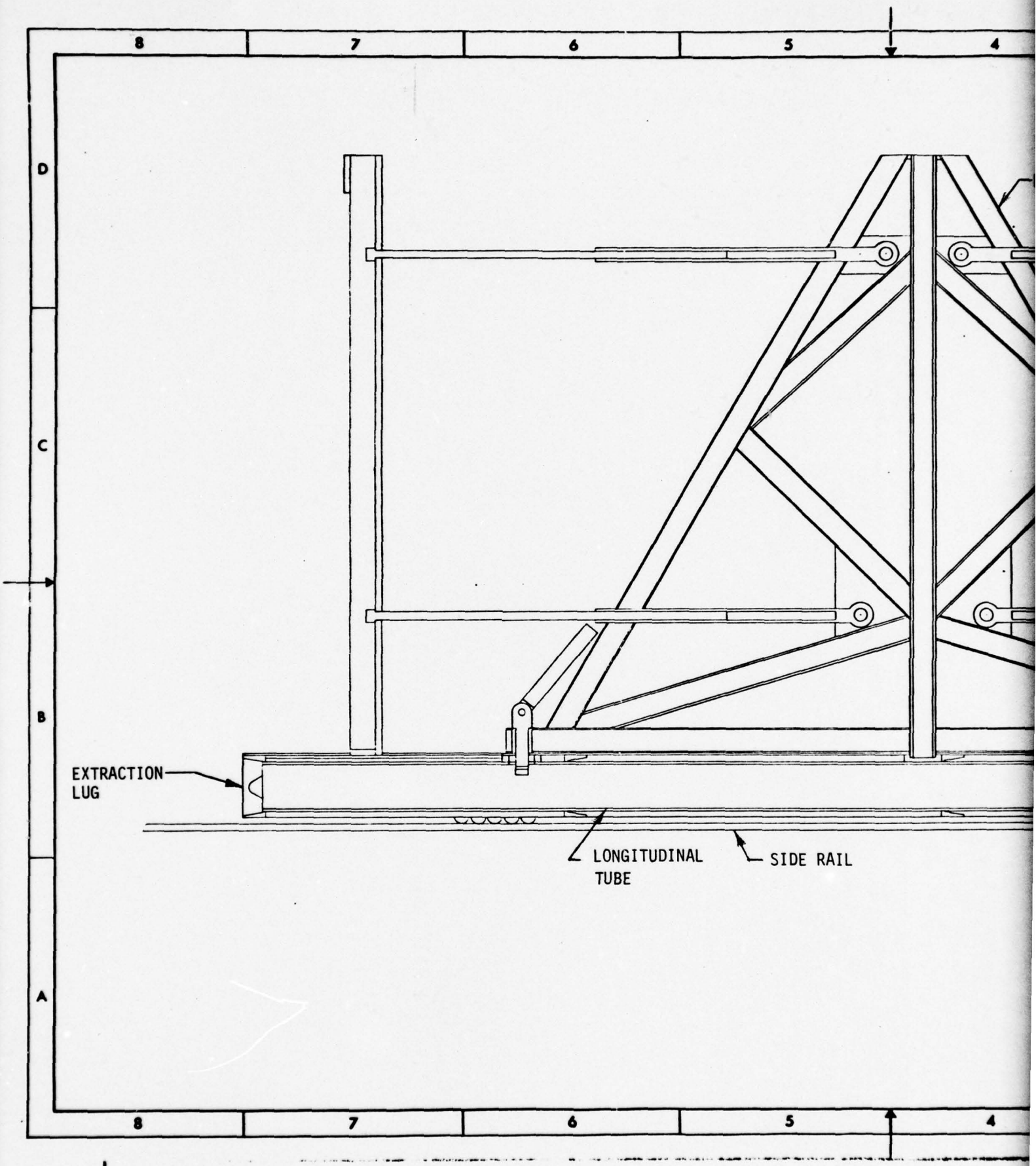
LIST OF MATERIAL

U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

Section Through Rollers Looking from Side

D 97403 Figure 6-6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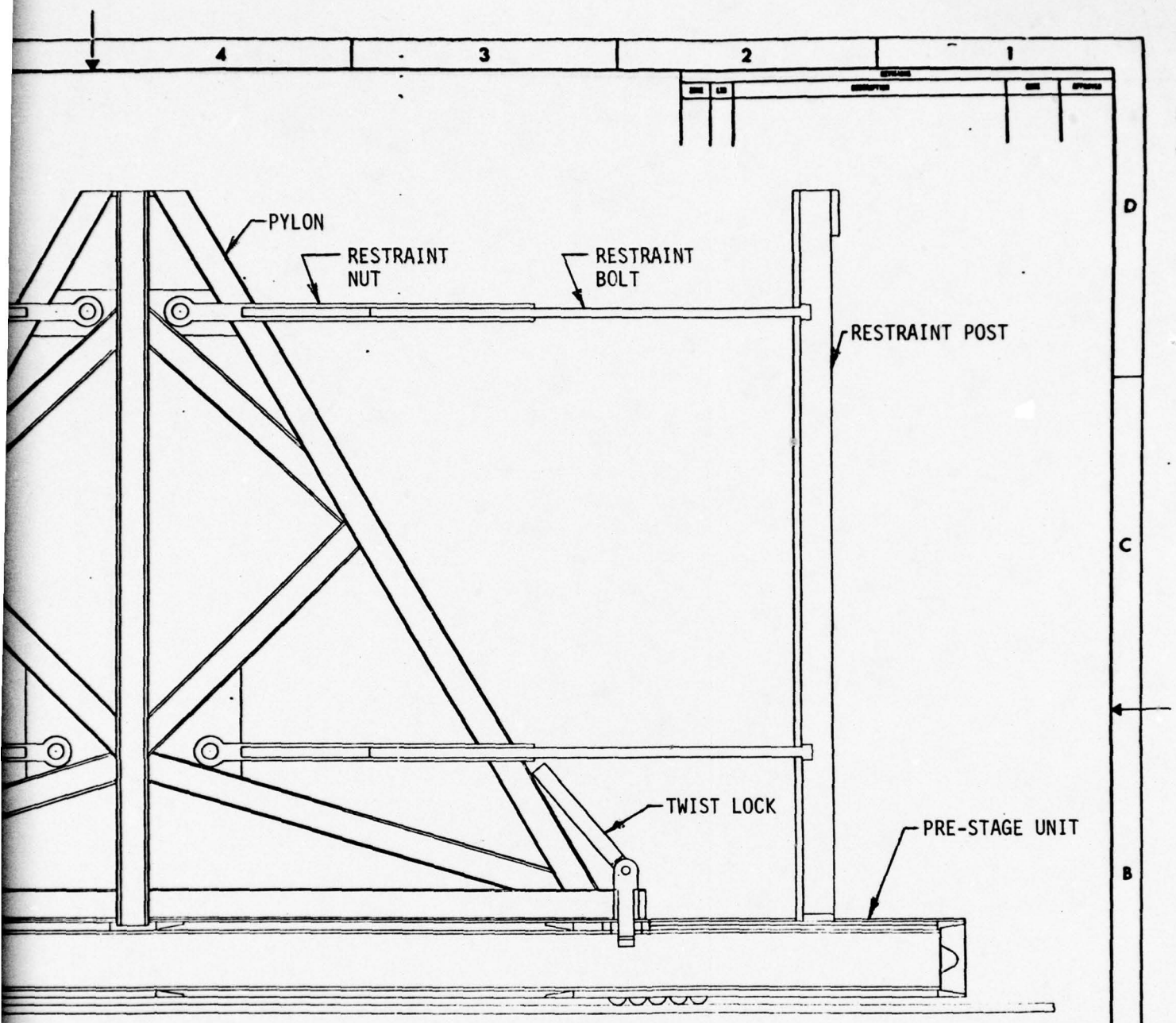

RAIL

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LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ANGLES ±
2 PLACE DECIMALS ±
3 PLACE DECIMALS ±

DO NOT SCALE THIS DRAWING

REMOVE BURRS AND BREAK SHARP EDGES
SHARP EDGES .10
FILLET RADII .10

MATERIAL

NEXT ASSY | USED ON

APPLICATION

DRAWN | DATE
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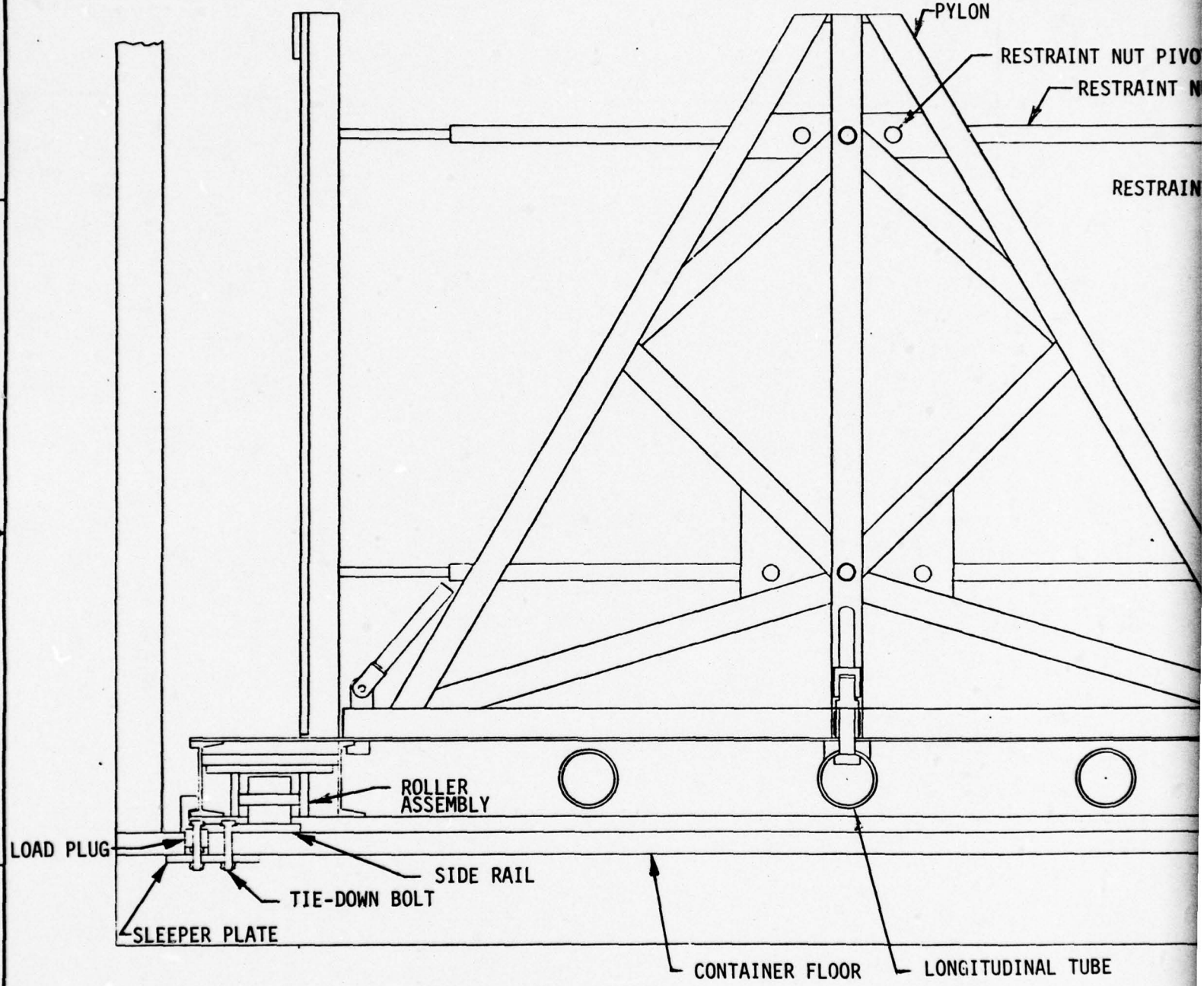
PROJECT ENGINEER
DESIGN APPROVAL
CONFIGURATION ENGINEER
PRODUCTION APPROVAL
PRODUCTION ENGINEER
DATE

U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

Section Through Center Looking from Side

SIZE D | CAGE IDENT NO 97403 | Figure 6-7

SCALE | SHEET


PYLON
RESTRAINT NUT PIVO
RESTRAIN
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LOAD PLUG
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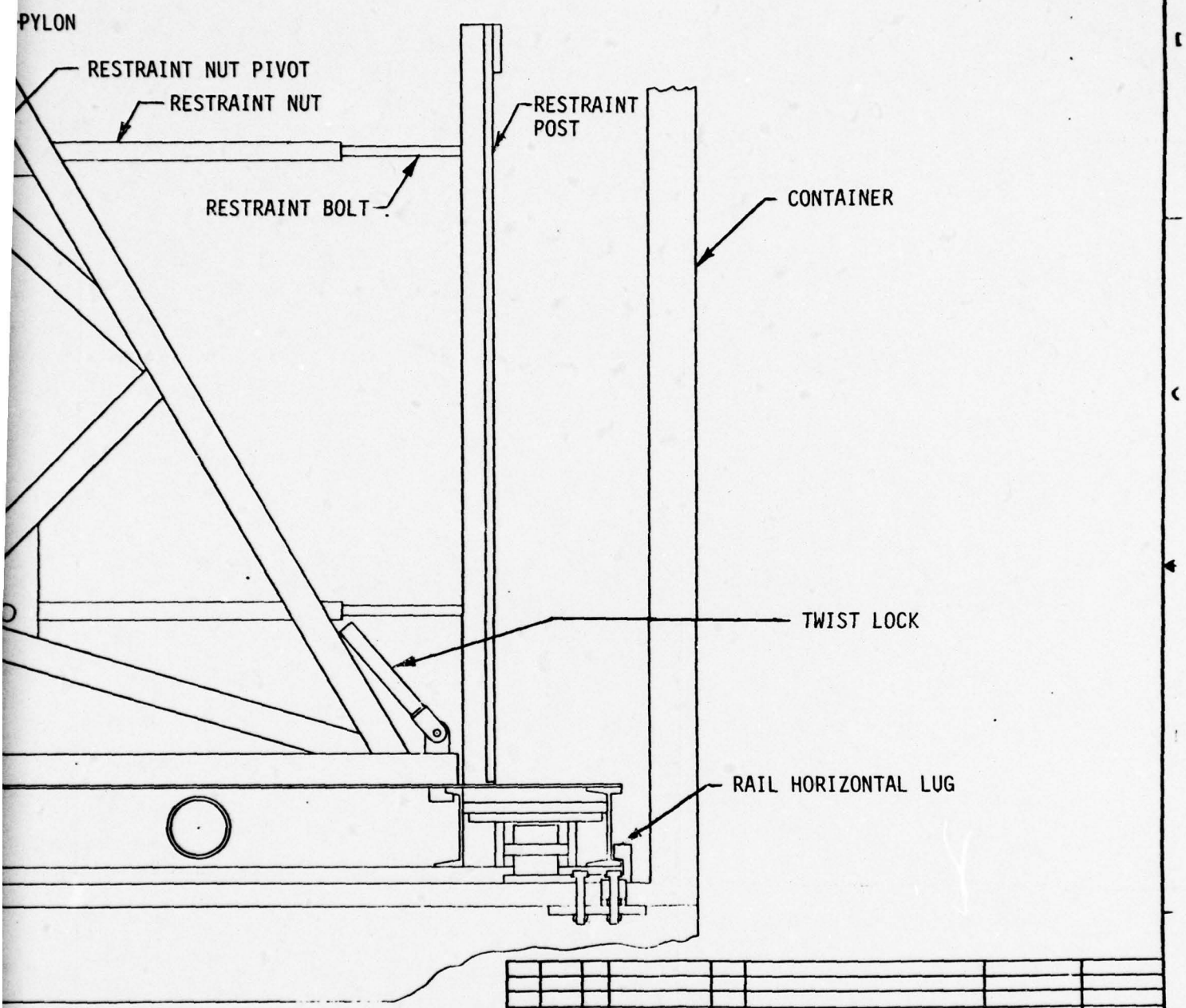
TIE-DOWN BOLT
SLEEPER PLATE
CONTAINER FLOOR
LONGITUDINAL TUBE



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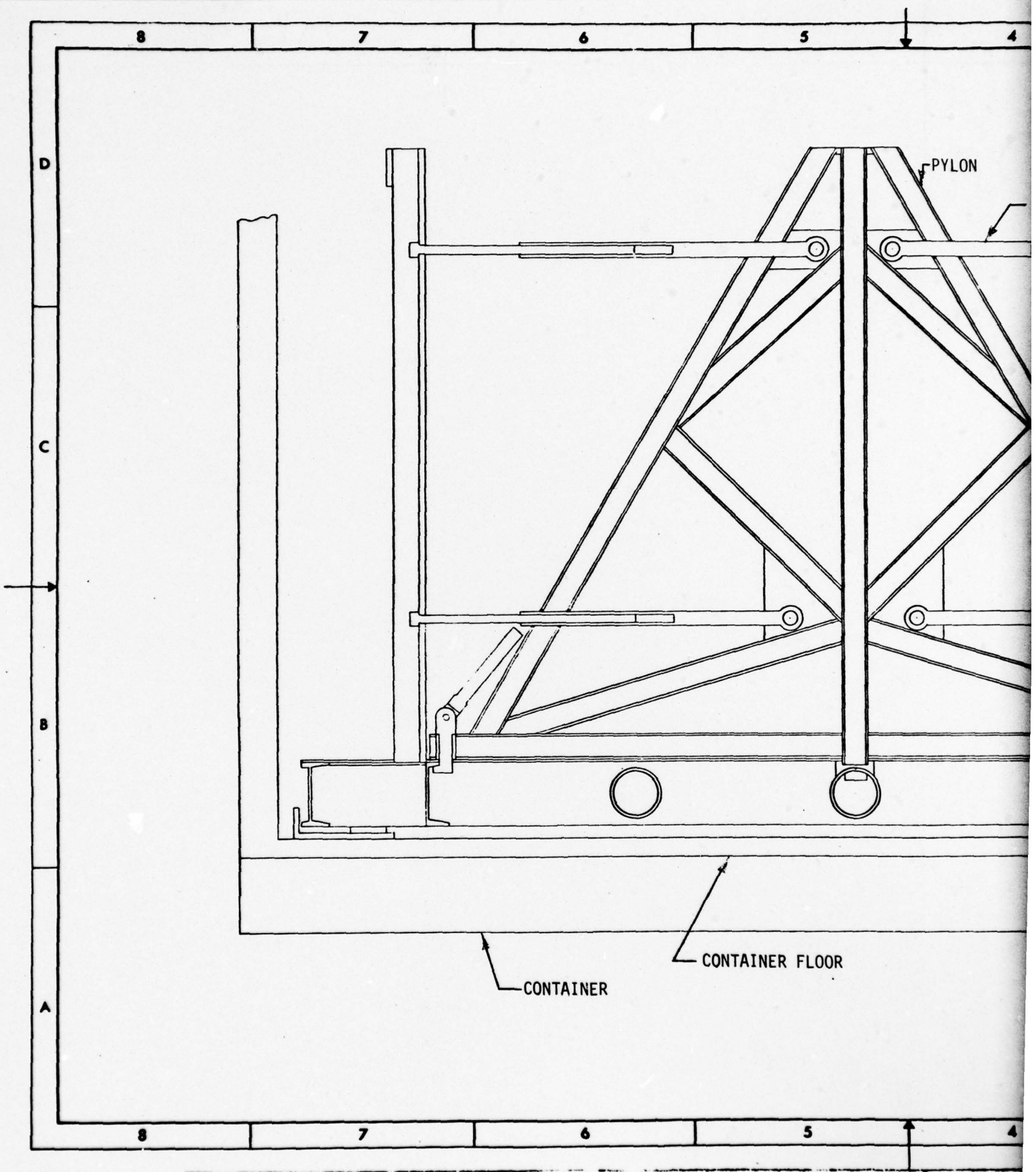
LIST OF MATERIAL

U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

Section Through Rollers
Looking from End

D 97403 Figure 6-8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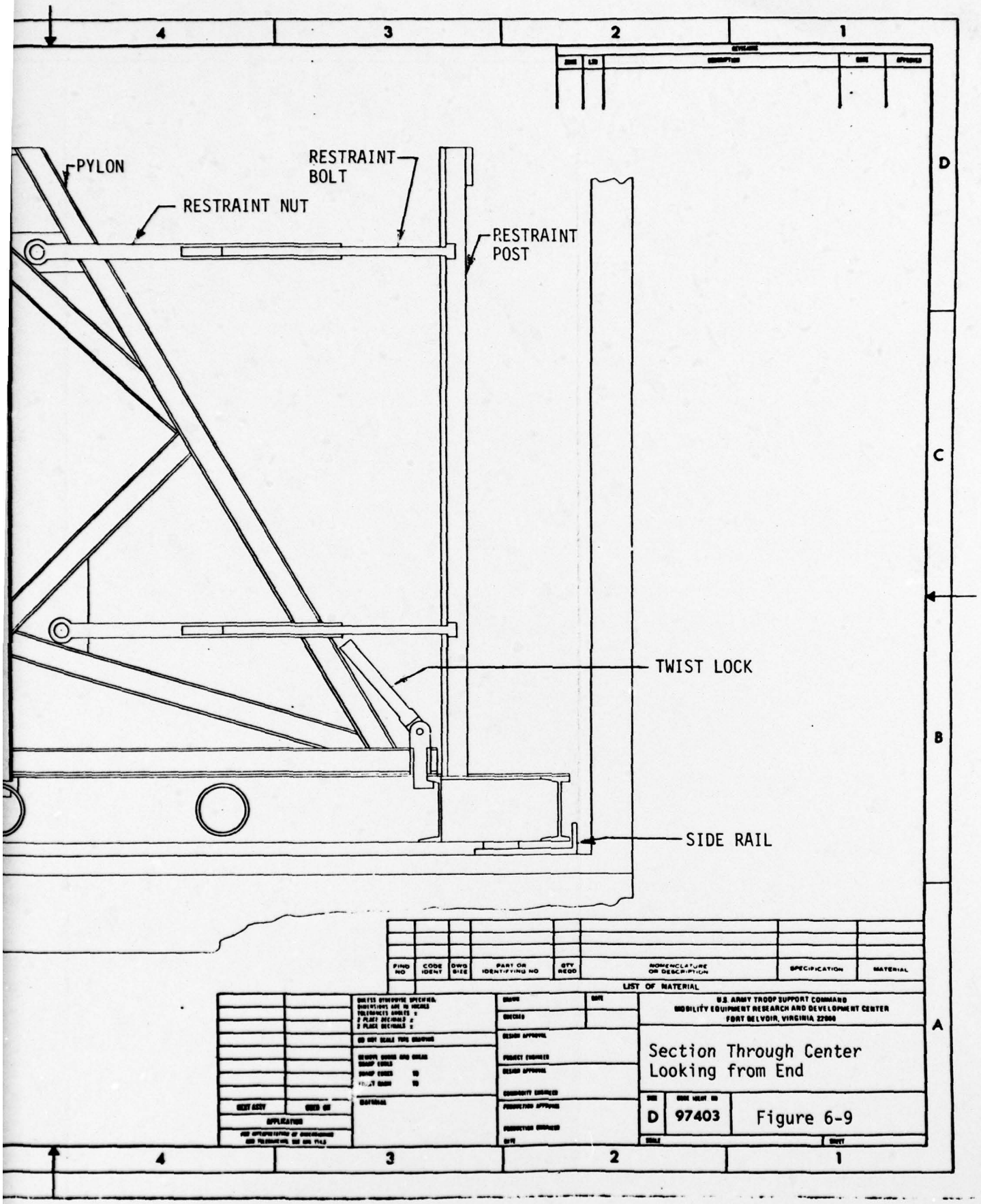
PYLON
CONTAINER FLOOR
CONTAINER



FIND NO	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL

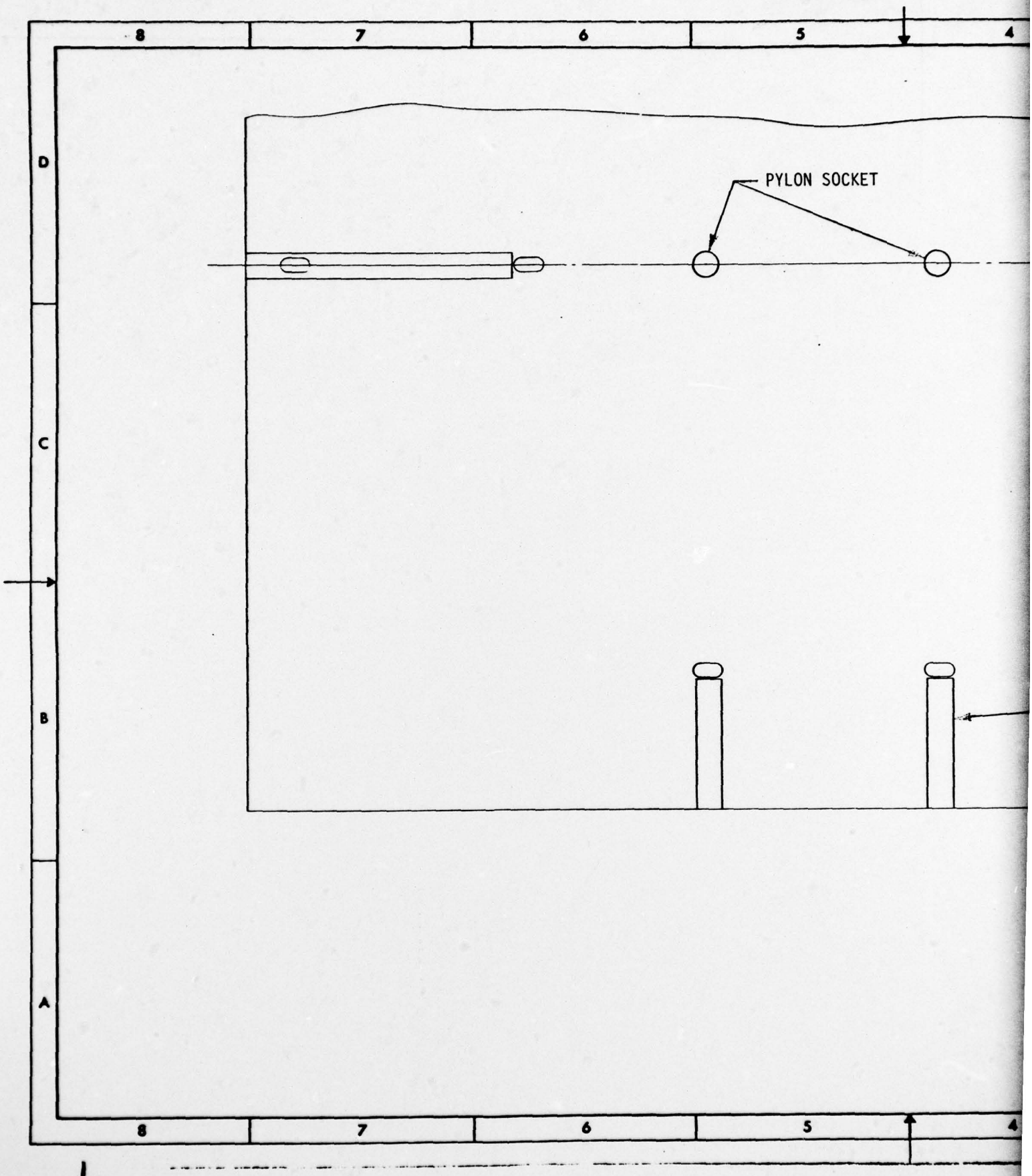
LIST OF MATERIAL

U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

Section Through Center Looking from End

SIZE	CODE IDENT NO	
D	97403	Figure 6-9

2


8
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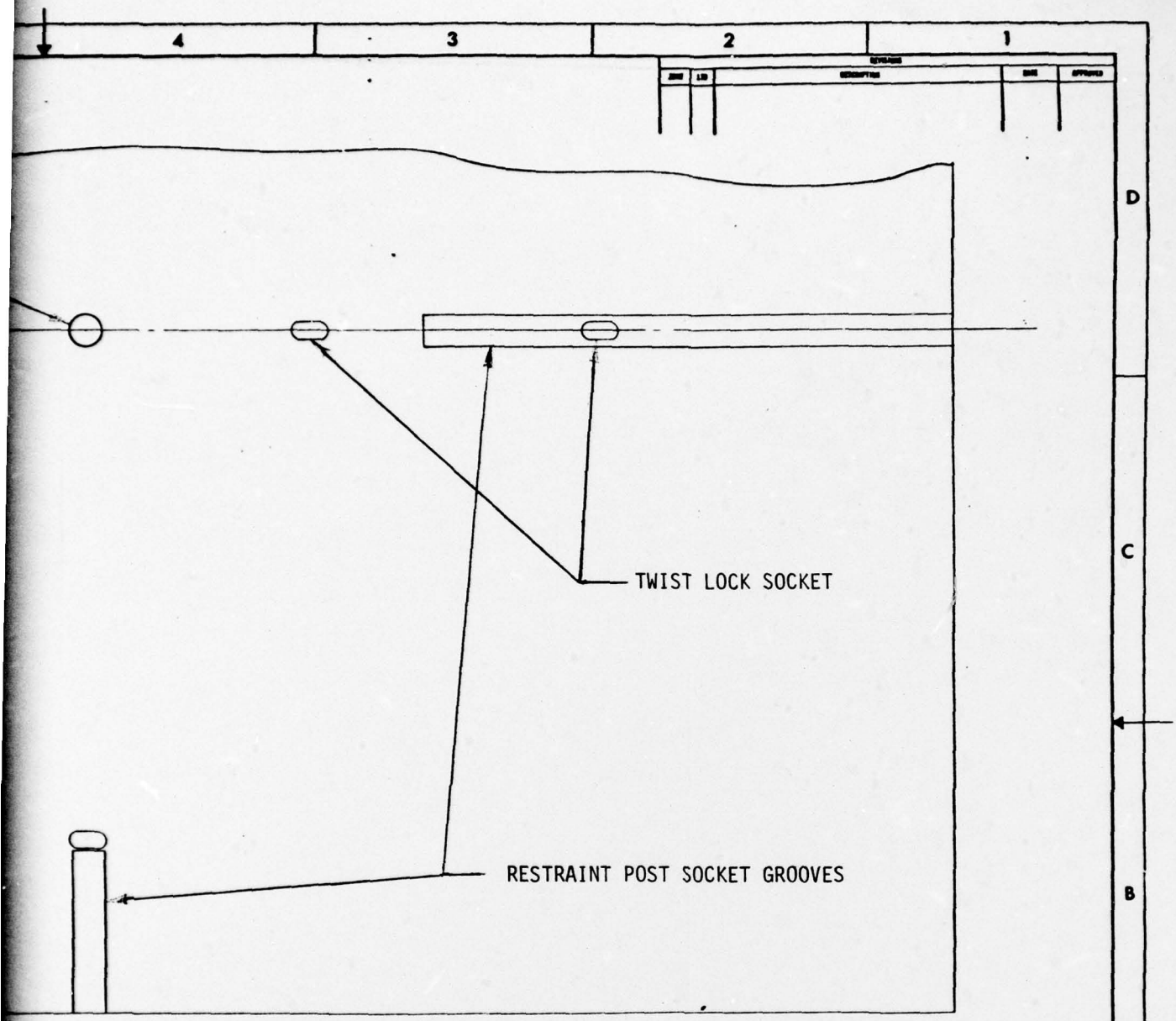
PYLON SOCKET



FIND NO	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL

LIST OF MATERIAL

U.S. ARMY TROOP SUPPORT COMMAND
MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

Top View of Pre-Stage Unit
(Pylon Removed)

SIZE	CAGE IDENT. NO	Figure 6-10
D	97403	

In use, the pylon is attached to the platform with the twist locks. Cargo is then fitted into the corner between two adjacent legs. The restraint posts are drawn lightly against the two outer cargo corners in line with the pylon legs and the tension rod hooks placed over the upper platform flange and also drawn up lightly. Horizontal restraint straps are hooked to the restraint posts and drawn up tight. The restraint bolts and tension rods are drawn up tight. Vertical restraint straps are placed over the cargo, hooked to the upper platform flange and drawn up tight. Thus, the cargo is held against the pylon by both the restraint posts and the horizontal straps. In the event of an axial acceleration, the cargo portions tending to move into the pylon will be restrained by the pylon at their inner corners and by the side posts at their outer corners. The post loads will be reacted by the upstream tension rod at the top and the socket groove at the bottom. Cargo tending to move away from the pylon will be restrained at their inner corners by the end post and at their outer corners by the horizontal straps. The end post will be restrained by the two restraint bolts and the horizontal straps by the side restraint posts. Side accelerations are resisted in a similar manner.

Before the pre-stage units can be mounted in a container, the track assembly shown on Figure 6-4 must be attached to the container floor. The track is attached by means of tie-down bolts shown on Figure 6-8, extending through both the floor and a sleeper plate placed under the floor. Several holes are shown at each tie-down location on Figure 6-4. This will permit holes to be selected that will not interfere with the container structure cross-members. For each pair of side-by-side bolts, the inner hole will provide a generous clearance for the bolt. However, the outer hole will be bored large enough to accept the load plug shown on Figure 6-8. This plug is attached tightly to the bottom of the side rail prior to installation of the rail into the container. The upper portion of the plug mates with a female registering diameter in the side rail, thus allowing shear loads to be transfered from the plug to the rail without causing a bending load on the bolt.

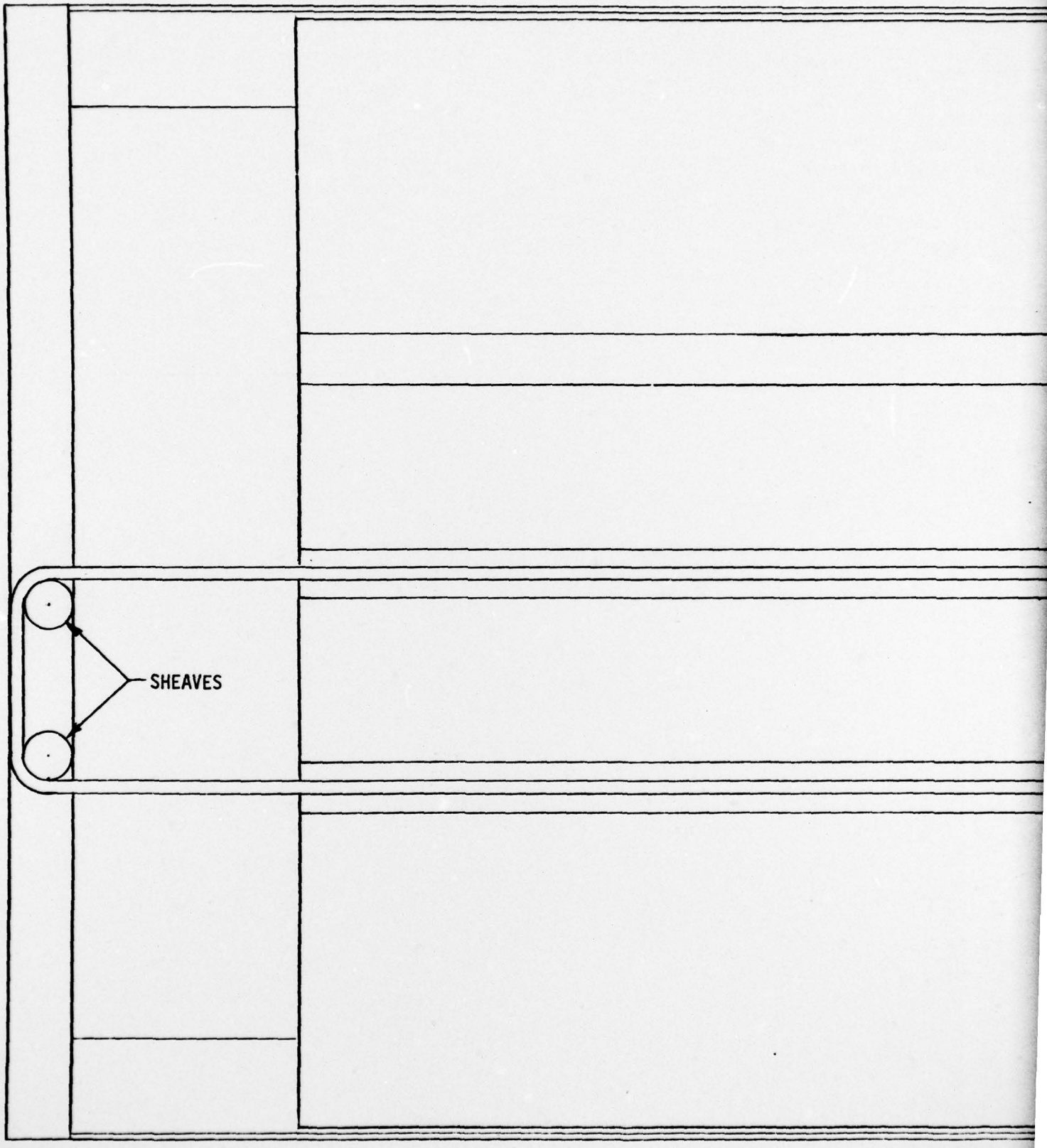
Integral parts of the rail are horizontal lugs. These lugs extend out over the lower flange of an installed pre-stage unit, restraining the unit in a vertical direction. On the track at the far end from the container door, a crossmember provides stops for axial acceleration and a support for the rail sheave assembly. While it is true that industrial tractors could push the pre-stage unit into position in the container, the sheave assembly presents a means of stuffing the units when such tractors are not available. By threading the rope through the tubular members and around the sheaves as shown on Figure 6-11. the pre-stage unit can be pulled into the container by pulling the rope out. When the pre-stage unit reaches the ends of the rails, it bottoms against the stop block which extends over the lower platform flange. When the unit is so positioned two additional stop blocks can be bolted to the rails at the other end of the unit, trapping it in place. The rope can then be threaded through corresponding tubes of the second pre-stage unit and this unit pulled into position. Two more stop blocks can be bolted in place, trapping the second unit in place. Thus restrained, the cargo and the units are ready for shipment. The above procedure applies to units with a lenth of 108 inches. If a 216 inch long unit were stuffed, only one unit would be used.

Two positions for the pylon are shown on Figure 6-10. The central position can accept four large pallets or skids or smaller cargo increments in multiples of four. The off-center position accepts six large cargo increments. Alternatives to the design shown include the following:

1. A three leg pylon can accept three extremely large cargo increments when off-set axially or five increments when off-set to the side.

2. A two leg pylon can accept two increments per pre-stage unit.

3. The horizontal rail lugs could be eliminated and the restraint blocks used to restrain both vertical and axial movement.


SHEAVES

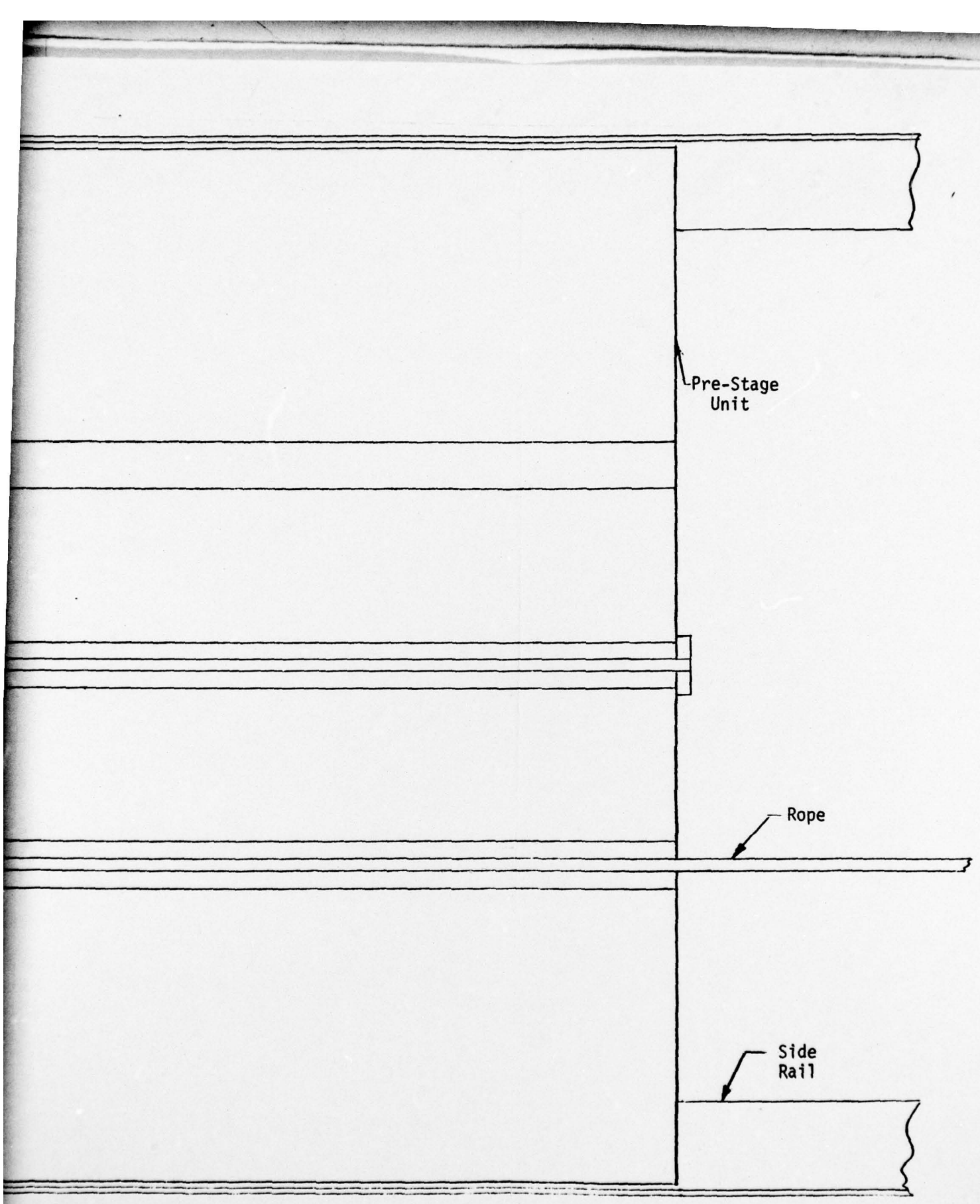


Figure 6-11
Stuffing Method

2

4. Additional roller assemblies could be used to eliminate any possibility of bottoming the ends or center of the pre-stage unit either in a dip or on a hump.

If cost and ease of fabrication are paramount considerations, the pre-stage unit platform and the pylon would be fabricated from cold rolled steel. If weight is more important, these items would be fabricated from aluminum. In the interests of safety, it is anticipated that all rails, both container and magazine, will be fabricated from beryllium copper to minimize sparking when the platform strikes against the rail.

Once the ammunition cargo is attached to this pre-stage unit, the unit can be handled as described below:

1. In magazines, three parallel storage tracks could be installed as shown on Figure 6-12. Each track could hold seven 108" long units or three 216" long units when installed in an 80 foot long magazine. Adjacent to the door would be a two track shuttle that would move sideways in the magazine on its own tracks. The center track would be filled by pushing the pre-stage units across the shuttle onto the track. To place a unit on a side track, the unit would be pushed on the shuttle and moved sideways to the track and then pushed on the track. As one unit is being pushed off the shuttle on to a side track, a second unit could be pushed on the other shuttle track to be moved to the other side when the shuttle is again moved. The pre-stage units would be inserted through the magazine door on a portable stub track placed at the door opening by a crane after the door is opened. The stub tracks would extend out in front of the magazine a sufficient distance to allow the crane to place pre-stage units on the track from a flat bed truck or vice-versa. The flat bed truck could act as a transfer platform to stuff the pre-stage units into containers on other trucks or could transport the units to a stuffing station.

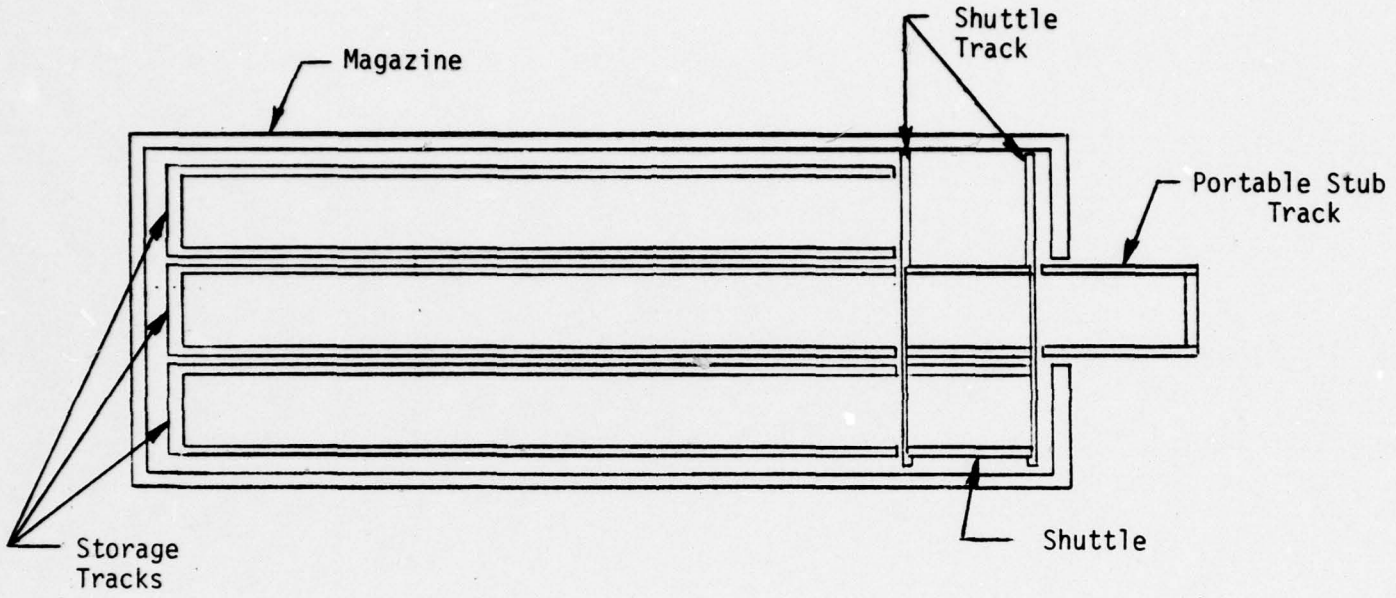


Figure 6-12
Magazine Storage and Handling
System for Pre-Staged Units

1. (Cont'd) Such an arrangement could hold 23 units 108" long or 11 units 216" long. It should be possible to insert or remove pre-stage units at the rate of 15 units per hour with a 6 man crew.

2. A stuffing station could be installed at depots and/or ammunition plants. The stuffing station could be configured as shown on Figure 6-13. Trucks with empty containers with installed guide rails would drive under the gantry crane. The crane would lift the container off the track and place it on the container cradle which would align the container with the pre-stage unit supply track. Pre-stage units would be pushed into the container and locked in place. The loaded container would be sealed and replaced on the truck by the crane. Placing the container on either the truck or the cradle is a simple matter as evidenced by container handling at container ports. Backing the truck to a loading dock in alignment with the supply track could be difficult. Use of the crane also eliminates any problems associated with height differences between the truck and the dock as well as truck spring defelction. The unit supply track could be replenished in many ways, including cranes, fork lift trucks, conveyors, etc. A boom type crane could replace the gantry crane but would probably be somewhat slower. Such a system should be able to load containers at the rate of 12 containers per hour with an 8 man crew.

3. Removal of the cargo from the pre-stage unit at overseas locations could be accomplished in several ways. One would be to back the container trailer to the end of a flat bed trailer, place a dock ramp across the gap between the two trailers, drag the pre-stage units out on top of the flat bed trailer and remove the cargo from either side with rough terrain fork lift trucks operating on the ground on either side. Another method would be to back a rail equppied 6 x 6 truck to the back of the container, drag one pre-stage unit across a dock ramp on to the 6 x 6 truck and lock it in place. The 6 x 6 truck could then transport the pre-stage unit to less accessable areas where rough terrain fork lift trucks

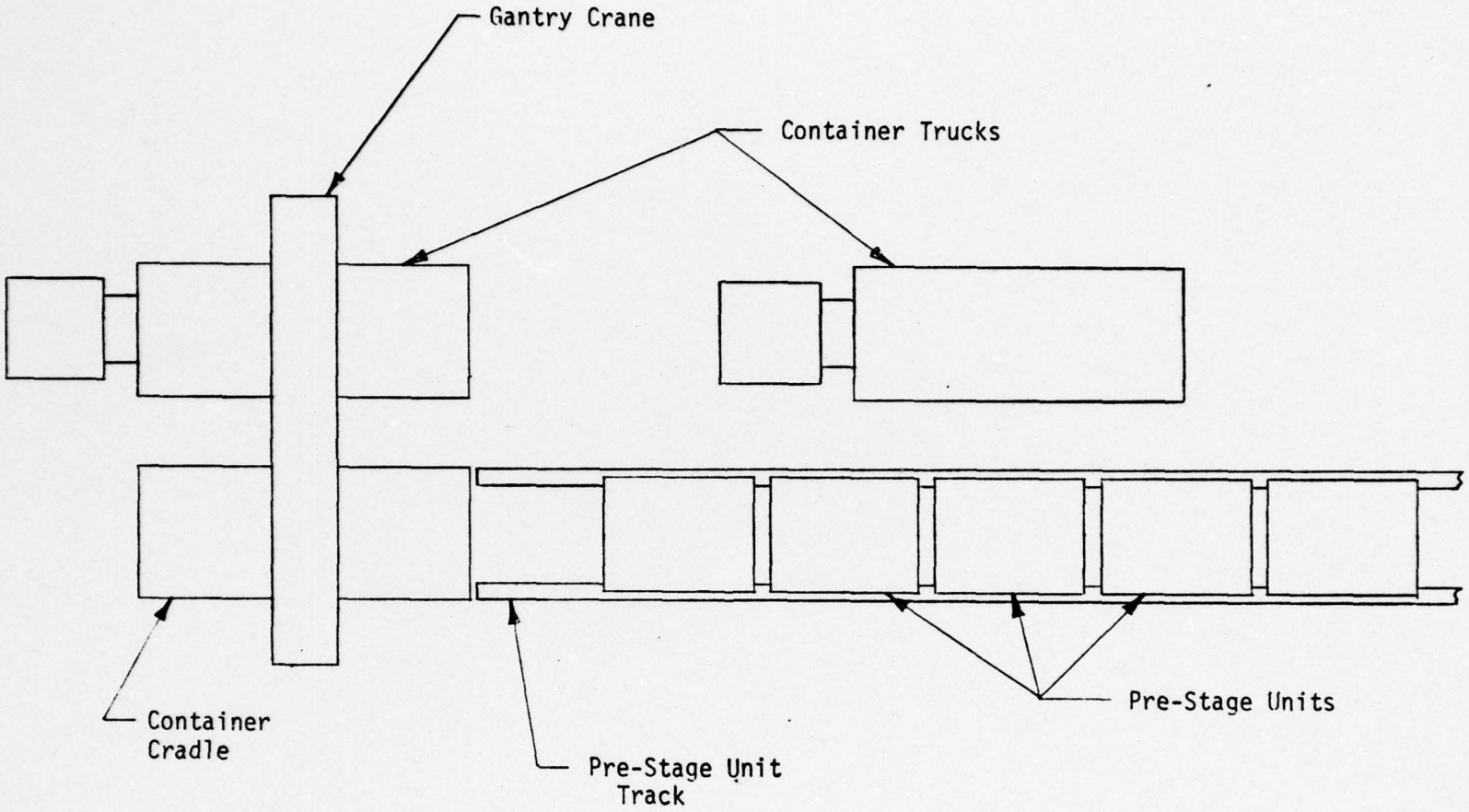


Figure 6-13
Stuffing Station

3. (Cont'd) would remove the cargo. If necessary. the cargo could be released and dumped on the ground by using a rope and driving out from under the cargo. Yet another method would be to release the cargo from the pre-stage units in the containers, skid the cargo to the container door and lift it off with rough terrain fork lift trucks operating on the ground. Still another method would be the use of a flat bed trailer as a platform for a fork lift truck that would drive into the container and remove the cargo. A pylon which could be separated might be required in some of these operations.

The estimated weight of the 108" pre-stage unit presented herein is 1350 pounds if fabricated in steel and 700 pounds if fabricated in aluminum. The rail assembly will weigh approximately 550 pounds. As shown, a safety factor of 3.0 can be achieved with the maximum load under worst conditions. The cost of each 108" pre-stage unit is estimated to be $1500.00 and the rail assembly $350.00.

VII. CONCLUSIONS

Based on the foregoing, the following conclusions have been reached:

1. An integrated pre-stage ammunition loading and handling system from ammunition plant to magazine to usage area can be devised.

2. The integrated system can utilize proven and readily available components, equipment and methods.

3. Use of such an integrated system can provide high volume output of pre-staged ammunition with a minimum expenditure of time and manpower.

4. An integrated system can be compatible with exsisting Army equipment and operating methods.

5. An integrated system can extend the range of supply of containerized ammunition by transfering pre-staged units to 6 x6 trucks.

6. The in-container portion of the integrated system in optimized form will likely weigh 1500 pounds to 2000 pounds and cost no more than $1300.

7. The preliminary design presented in this report can be optimized.

8. Pre-staging could be aided by developing a listing of preferred package configurations for those types of ammunition which are currently shipped in different size packages.

VIII. RECOMMENDATIONS

The following efforts are recommended:

1. Perform an in-depth study of the ancillary equipment required at ammunition plants and storage magazines for pre-staging ammunition.

2. Prepare a detail design of the pre-stage unit or units anticipated for Army usage, optimizing the design to the maximum extent possible.

3. Prepare a listing of preferred ammunition packages.

4. Fabricate operating scale models of pre-stage units and their associated equipment.

5. Fabricate four prototype units, modify one 60' magazine and mock-up one container stuffing station for developmental testing to simulate all phases of the pre-stage operation.